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THE OLD MILL IN AGRICULTURAL HALL.

THE immense windmill is a very odd feature of the Exhibition, among the exhibits in Agricultural Hall, and by reason of its shape and size, no less than by its silent reminder of the slow and uncertain process of treading grain in the olden time. In its interior are all the pieces of rude machinery, together with the burrs necessary for the reduction of the fresh grain to flour. It appears extremely singular to the majority of visitors by contrast with the most compact, thorough and positive machinery of the present day, and this novelty is greatly increased by the knowledge that, with all the mechanical devices of the last fifty years, thousands of mills, even ruder in construction and more primitive in appointments than this, are seen in various parts of the United States and in foreign countries, making noticeable dots in patches of beautiful scenery. When we see scattered throughout what should be prosperous localities such specimens of antiquity still in operation, it does not look as if the progress of civilization, and the arts and sciences, has been quite as lively as is generally believed.—*Frank Leslie's Illustrated Newspaper.*

THE INTERNATIONAL EXHIBITION.

J. MORTON POOLE & CO.'S METHOD OF PRODUCING ROLLS.

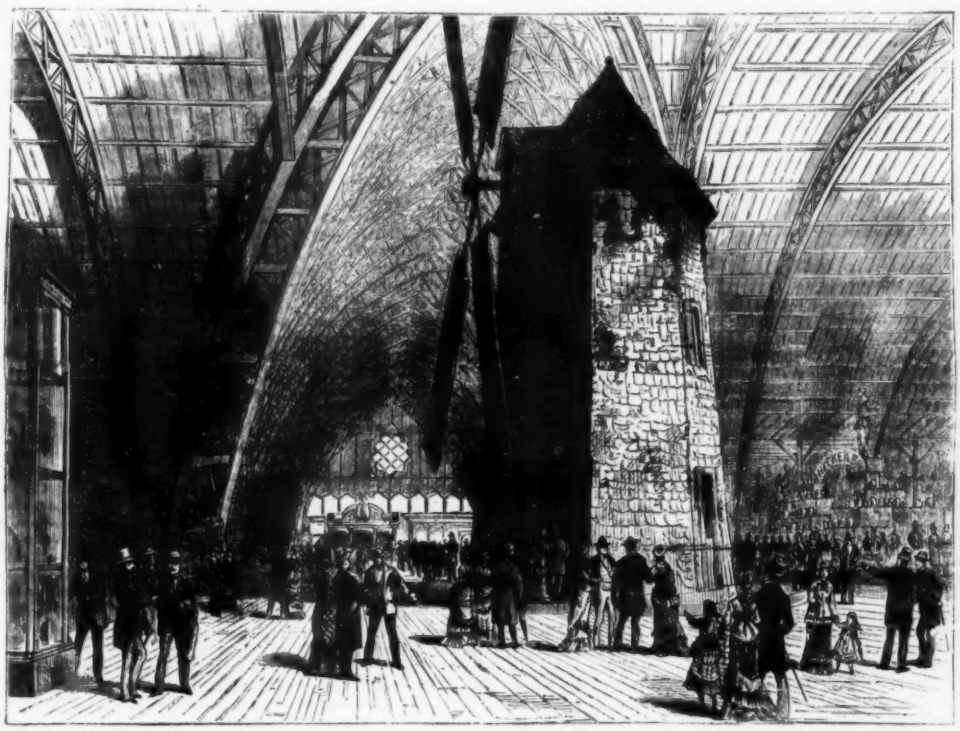
NEITHER a truly round nor a truly parallel roll can be produced by steel turning-tools: first, because of the abrasion of the tool which takes place as the cut proceeds; second, because the tool will spring into the softer and away from the harder parts of the metal; and, third, because a steel-cutting tool requires to be rigidly fixed to the slide rest, since the latter moves in a line whose straightness and trueness with the centres of the lathe depend upon the degree of truth existing in the lathe bed. By taking a pair of rolls which fitted together so closely as to exclude the light from passing between them, and then inserting between them foil of a known thickness, Messrs. J. Morton Poole, of Wilmington, Delaware, have ascertained that it requires a width between them equal to the four thousandth part of an inch to permit of the passage of light.

Now, when it is remembered that the imperfections in the bed are doubled upon the roll, and that if, therefore, the lathe bed be out of true to the eight thousandth part of an inch only, the rolls will be sufficiently out of true to permit the light to pass between them in the low or hollow places, the impracticability and mechanical impossibility of producing a true roll by any system which depends upon the truth of the bed, becomes at once apparent. For the bed will vary to a considerable degree in its straightness in consequence of the variation in its temperature due to the temperature of the atmosphere. Then, again, the cuttings or dust falling upon the surface of the bed pass between it and the lathe carriage, causing abrasion; and furthermore, the bed suffers the most wear upon that part of its surface over which the carriage traverses when operating upon short rolls. The necessity for a greater degree of truth in a roll than can be obtained when depending upon the straightness of a lathe bed will be readily perceived if we suppose a pair of rolls to be the 10,000th part of an inch out of parallel, and the paper rolled by them be therefore the 20,000th part of an inch thicker on one side than on the other. Now, suppose a roll of such paper to be 33 inches in diameter, the mandril upon which it is rolled being 3 inches thick, and there to be 450 thicknesses of paper to an inch, the roll would in such case be .675 of an inch in diameter or 2.12 inches in circumference greater at one end than at the other and the effect of such a roll being placed upon a modern printing-press through which it would require to be drawn at a speed of from 15 to 20 miles an hour, needs no comment.

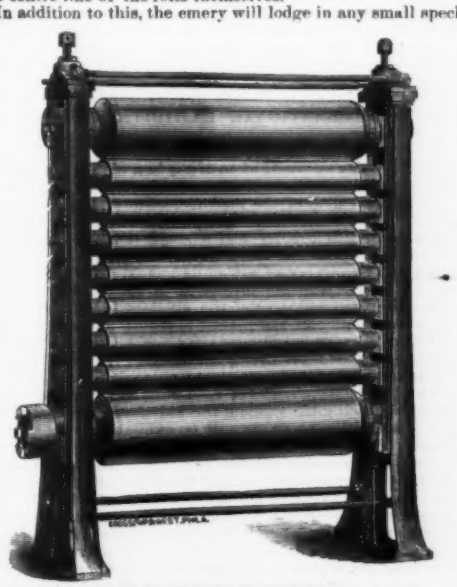
To remedy the inaccuracy due to the defects of steel tool-turning, emery and other wheels have been and are still by some employed in the position occupied by the turning-tool. The defects of this system consist in that, as above explained, the want of truth in the lathe bed is reproduced multiplied two-fold on the roll. Then, again, in the case of emery wheels, they must be used without the application of water, and the roll becomes heated as the cutting proceeds, producing an irregular expansion. Furthermore, those parts operated upon the most by the emery wheel become locally heated and hence locally expanded, so that the emery wheel removes more metal than is requisite, and that which was a high place or spot before operated upon by the wheel, subsequently becomes a low one after cooling. If stones and water are employed, the softer parts of the stone abrade the quickest, producing not only unevenness in the cut, but a tremulous motion of the wheel in consequence of its being out of balance.

With a view to remedy as far as possible the defects inherent in the above methods of manipulation, the following plan has been, and still is sometimes adopted: The rolls are placed in frames in the position occupied by them when in use, and connected together by gear wheels so as to revolve in the same direction, the surfaces being supplied with fine emery and oil, to the end that they might grind themselves true. The defects of such a plan are that the softer parts of the roll will grind more readily than the harder ones; and since the rolls are cast upright—that is to say, endwise—the metal at the bottom is, in consequence of the weight of the metal above it, more homogeneous than it is at the top, and therefore wears the least in the grinding. If, therefore, the softer ends of two rollers come in contact they will grind taper, the line of contact between the rolls will be out of true with the centre line of each roll, while the centre lines of the rolls will stand out of true one with the other; and if the harder end of one and the softer end of the other roller meet, the line of contact of the rolls will still be out of parallel to the centre line of the rolls themselves.

In addition to this, the emery will lodge in any small speck there may be in the rolls, and operate to scratch the surfaces, while the gearing causes a vibration to the rolls which is plainly detected in the finished roll. Moreover, the whole tendency of the operation is to cause the rolls to fit one to the other along the line of contact, irrespective of either their roundness or straightness, since the process would answer equally as well to grind oval as to grind round rolls. From these considerations it becomes apparent that, should one roll require re-grinding, the whole set or stack must be sent to the shop with it.



THE INTERNATIONAL EXHIBITION OF 1876.—THE OLD MILL IN AGRICULTURAL HALL.



ROLLS AT THE EXHIBITION.

The system adopted by Messrs. Poole is as follows: The bearings of the rolls are first turned in the lathe by steel tools formed from the crescent steel made by Messrs. Millarbarr & Parkins, which steel has a distinctly sulphurous smell, and can be heated to an unusually high temperature for the hardening. The tool is made for roughing out purposes about 6 inches, and for polishing purposes about 10¾ inches long. The tool is ground, by an emery wheel, flat upon the top and bottom surfaces, so that while the bottom face rests evenly upon the face of the lathe rest, the top face stands horizontally level with the length of the roll. The other two faces are recessed an eighth of an inch deep, the recess running to within about $\frac{3}{16}$ inch of the cutting edge. This is done to facilitate the grinding by reducing the area of metal to be removed in the sharpening process. The angle of the side or vertical face is about 70°, which is maintained constant by sharpening the tool in a special emery wheel and frame. The cutting speed employed is from 8 to 16 inches per minute. The tool is fed for both the roughing and finishing cuts diametrically into the roll by an ordinary cross feed, the cuttings being, of course, 6 inches for roughing, 10¾ long for finishing cuts, and resembling ragged pieces of fine wire. When the tool has been fed in to the requisite depth it is withdrawn, the rest is moved along about the requisite distance—that is, 6 or 10¾ inches—and the tool is again fed into the diameter of the work, so that for feeding the tool to its cut only the cross feed of the lathe is employed.

The ends of the rolls are faced off by an emery wheel supported in a frame attached to the slide rest, the frame being operated by the slide rest screw. The driving belt for the emery wheel passes beneath a pulley sustained by a frame fastened upon the tail stock of the lathe, and thence to the pulley on the emery wheel arbor. After the roll has been turned as accurately as is practicable with the steel tools, it is finished in the grinding lathe or machine, and the principle upon which this lathe operates is as follows: If we suppose the lower part of a compound lathe carriage to support the upper part so as to permit to the latter a free, swinging, cross-feed motion, and form it so as to carry two revolving corundum wheels, one on each side of the roll, so that the horizontal centre line of the roll will be level with the centres of the corundum wheels, it is evident that the two will form a pair of grinding callipers, and will adjust themselves to touch the roll equally on both sides, just the same as the points of a pair of callipers, held loosely, will adjust themselves to the diameter of a roll. It is also evident that a pair of wheels adjusted in this manner, if traversed along the roll, will come in contact with, and operate upon, the roll in places where the diameter of the roll is equal to or exceeds the nearest width between the two corundum wheels, while such parts of the roll as are of a diameter less than is the said distance between the wheels will remain untouched. If, therefore, the wheels are adjusted in their distance apart and operated along the roll until all the turning marks are effaced, the roll will be made quite parallel except in so far as the reduction in the diameters of the grinding wheels and the deflection or sag of the roll may prove disturbing elements.

The latter element is of no practical moment, however, since its effect upon an ordinary roll 8 feet long has been computed not to affect the diameter of the roll to more than the two hundred thousandth part of an inch. Referring to the first disturbing element, it is less in the process adopted by Messrs. Poole than in any other yet known for the following reasons: The ordinary plan is to perform the grinding with a wheel on one side only of the roll. Now, supposing it to be practicable to move the carriage containing the wheel so delicately as to be able to put on a cut the one hundredth part of an inch in depth, the diameter of the roll will be reduced one fiftieth of an inch, and the amount of the abrasion of the emery wheel will be that due to the abrading of that quantity or weight of metal; but if the feed of one of Messrs. Poole's corundum wheels is moved the one hundredth of an inch, the reduction in the size of the roll will be the one hundredth of an inch only; so that, with the same amount of feed, Messrs. Poole take off only one half the amount of

metal, and have twice the area of grinding wheel to do it with; hence the deviation from parallelism is only one fourth as much under their process as it is under the process usually employed, presuming the quality of the wheels to be the same in both instances; this, however, is not the case, for the following reasons: Messrs. Poole conducted a long series of experiments with various kinds of wheels, whereby to test their relative qualities to resist abrasion, and finding them all so defective in this respect as seriously to interfere with the production of parallel rolls, they searched into the causes, among which they found that, aside from the impurities in the grain emery which they eliminated by washing, the edges of the angles of the grains of emery were all more or less rounded, destroying the cutting qualification.

From these and other causes it was determined to use corundum, and a search in different States was instituted to find pure corundum. About 15 tons was finally secured, and from this the concern manufactures its own wheels, in which process the greatest care is taken. The corundum is crushed to a grade equal to about No. 36 emery, special attention being directed to crush the stone in a manner to preserve the cutting edges of the grains. The material employed to cement the corundum into the form of wheels, the firm have no desire to disclose. Certain it is, however, that the wheels are far superior in durability to either ordinary emery or corundum wheels, and that used as they are with a liberal supply of water, the abrasion due to one traverse along a roll is practically infinitesimal.

From the cross-swing motion, then, of the frame carrying the corundum wheels, the parallelism of a roll is inevitable, providing that the roll runs circumferentially true. The ordinary method of grinding a roll to run true in the lathe is to grind it up with one emery wheel in a fixed position, and this was the plan formerly employed by Messrs. Poole, in which case the advantage obtained by their process was that since an emery wheel in a fixed position will grind a roller to run true, and the error arising from its use lies in the parallelism of the roll, it is necessary only to finish the roll with the two wheels in position to insure both roundness and parallelism. The only objection to this plan was that the grinding the roll true could be performed twice as quickly with the two wheels as it could be with the one, and could be proceeded with simultaneously with the truing for parallelism. The method of accomplishing this result is as follows: By placing a slight pressure upon the frame carrying the corundum wheels, so as to offer a slight resistance to its cross-swing, the high spots or places upon the roll will press more heavily upon the respective corundum wheels as it passes them, and, as a consequence, will suffer the most abrasion. This remark applies, however, to high spots, which do not extend entirely around the circumference of the roll, and not to high places due to an increase of diameter; or, in other words, it applies to those high spots which constitute a want of truth or roundness in the roll. If then a roll being out of round and out of parallel is operated upon with the wheel frame or carriage slightly resisted, the truing for both roundness and parallelism will progress jointly; then when the roll is ground so as to run true, the wheel carriage is allowed to swing freely while the finishing traverses are being made.

The speed at which the emery wheels revolve is about 5000 feet per minute, while the feed of their traverse is about $\frac{1}{16}$ of an inch. The size of the wheels is, when new, 9 inches in diameter by 1¼ thick. They are gripped or held upon a cast-iron centre-piece, which is in turn fast upon an arbor or spindle, a tight driving fit, the employment of keys being dispensed with, because of their liability to throw the work both out of true and out of balance. The arbor is of cast-iron, and is provided with long conical bearings at the ends, which admit of very accurate adjustment. Outside of these conical bearings, at each end, is a small turned tit, which serves in the balancing operations. The wheels are driven by two small pulleys, which are a tight driving-fit. To secure uniform weight in the iron of which the centre-piece, arbor, and pulleys are made, it is cast in upright sticks, and the lengths being cut off diametrically from the sticks, uniformity in the density is secured. After the centre-piece is put on an arbor, it is balanced. A pulley is then added, and the balancing process is repeated. The corundum wheel is then fastened to its place, and is balanced by first ascertaining the side on which it requires to be lightened. The arbor is then put on a lathe, and thrown slightly out of true at the running centre end, and in the necessary direction, and it is then trued up on the side face, the process being continued until the wheel is balanced. By this means the wheel will remain true as long as it is in use, notwithstanding its wear. After the other pulley has been put on, the balancing is again tested and corrected. The driving belt for the wheels is operated by two overhead drums of sufficient length to enable the wheels to traverse along the longest rolls. The belt is a continuous one, passing over both overhead drums and under both the wheel pulleys. The lower drum is made of smaller diameter than the upper one, to allow the belt to clear.

The circumferential speed of the two drums is equal, except that an allowance is made for the thickness of the belt, the outside of which runs over one drum, while the inside runs over the other. Both drums are drivers, since if either were made an idler, the belt would run tight on one side and slack on the other side of the wheels, giving to them an uneven and tremulous motion. The belt is arranged so that it drives both the wheel arbors in a direction opposite to that in which the roll revolves, so that the wheels shall both run against the cut, which tends to steady them.

The grinding lathe may be thus briefly described: The bed or frame rests upon the floor foundation, and not upon legs. The driving spindle is hollow, and is operated by a belt wheel of 6 feet diameter, and about a 5-inch face. To carry the roll there are two upright frames, adjustable, along the length of the bed, in grooves planed in the latter for the purpose. At the top of these frames is a box to receive the bearings, in which the necks of the rolls revolve. The bearings are composed of three sections, the two side ones of which are adjustable by means of set screws, while between the sections are two vacant spaces, which facilitate the adjustment of the bearing sections, and render it much finer than it otherwise would be. The roll then rests in the bearings provided in these frames, and is driven by a socket-driver, termed a wabbler, one end of which fits over the square end of the roll, while the other end passes through the hollow spindle, and is driven at the outside or belt-wheel end, the object being to avoid the use of gearing, which would impart a tremulous motion to the roll, and at the same time to extend the torsional movement due to the driving of the roll over as long a line as possible, so that it shall not tend to lift the roll in the frame bearings.

The lathe rest travels along the bed in the usual way, and is fed by a screw running along the middle of the bed, so as to cause the travel of the rest to be performed as easily and as uniform as is attainable. The lower part of the rest carries uprights, from which the upper part carrying the corundum wheels is swung or suspended by knife-edge levers so that the upper part frame, or carriage, as it may be termed, can swing crosswise but not lengthwise of the roll, as has been already described.

The roll to be ground is placed with its bearing at each end, supported by the bearings provided in the upright frames, which operate in the place and stead of lathe centres, and is slowly revolved. The revolving corundum wheels are adjusted to take very fine cuts, and are traversed by the lathe rest back and forth along the revolving roll. If the roll when in actual use operates under its normal temperature, it is liberally supplied with water during the whole grinding operation, a stream of water running upon it over the two grinding wheels, and one also at each end over the bearings in the frames. If, however, as is for some purposes necessary, the rollers are heated to a certain temperature, the roll is kept heated to a similar temperature during the grinding operation, so that any inequalities due to unequal expansion is as far as possible obviated.

Our engraving represents the stack of rolls exhibited by Messrs. Poole in Machinery Hall, at the Centennial. It will be observed that the bottom roll being unsupported must deflect from the weight of the rolls above it as well as from its own weight, and must therefore be ground to a conformation necessary to compensate for this deflection. This object Messrs. Poole accomplish as follows:

To the lathe bed is bolted two bearings which firmly grip a guide or former roll, ground up true and parallel and standing on a line with the length of the bed, and hence parallel with the roll being operated upon. Fast upon the bed and centrally located between the bearings carrying the guide roll, is a lug whose vertical face is true and stands about ⅛ of an inch from the guide roll. The horizontal top face of this lug being faced off, a key having a jib-head is fitted between the guide roll and the lug, so that when the jib of the key meets the upper face of the lug the guide roll will stand parallel, and not be sprung at all by the jib key. Having ascertained then the degree to which a roller of a given size and weight, and with a known quantity of weight resting along its upper surface, deflects, it is only necessary to place between the guide roll and the lug a sufficient number of pieces of paper of a known thickness to equal the said amount of deflection, and to then force in the jib key until its head contacts with the top face of the lug, and the guide roll will then be sprung out of the straight line. If then the lower part of the lathe rest or carriage be made to bear against the guide roll instead of travelling parallel with the length of the bed, the necessary allowance for the deflection referred to will be made by grinding the roll to the required conformation.

The methods of testing rolls are various; the one formerly employed by Messrs. Poole was to place them side by side on a surfaced plate and move one while in contact with another, to then slightly rotate them and repeat the rubbing process. The result was a series of bright lines whose degree of continuity and brightness became the test.

Mr. Hulse, however, who is one of the English judges, suggested what is known as the gravity test—that is to say, the rolls are placed side by side with their bearings resting in V's, and the distance between the rolls is adjusted so that at each end a piece of truly surfaced iron called the test piece will fall slowly through by its own gravity. The test piece was then applied all along the rolls, the latter being moved occasionally in the V's. This is an exceedingly delicate test, as is shown that by adopting it Messrs. Poole discovered that a pair of rolls was the one fifteen thousandth part of an inch small in diameter at each end, which was found to be due to the increase of temperature at the ends of the rolls due to the friction of the roll bearings in the journal. Since then, however, Messrs. Poole obviate this defect by supplying a stream of water to the bearings. In applying the gravity test the amount of want of truth in a roll is measured by inserting with the test piece a piece or pieces of gold-leaf of a known thickness. The test piece itself is a piece of cast-iron 1½ inch long, 1½ inch wide, and ¼ inch thick, with holes drilled through it to lighten it. This method of testing proves the truth, roundness, and parallelism of the rollers at one and the same time, and is probably the most delicate one known.

On a recent visit to the workshops of Messrs. Poole, at Wilmington, Delaware, the writer witnessed the entire process in operation, and it is certainly the most perfect piece of machine manipulation he has ever seen. Each roll is an original one made true by the principles involved in its manufacture, and not from the truth of any of the machines in which it is operated upon. One of the less delicate tests is an interesting one. A piece of tinfoil of a thickness of the two thousandth part of an inch, as measured by Prof. Sweet, of Cornell University, was placed between a pair of rolls at one end, and the result was that the rolls gradually approached each other until they touched at about the middle of their lengths; the ray of light passing through the rollers being tapered down from the two thousandth part of an inch to nothing became divided up, producing the prismatic colors. A set of rolls produced by this process may be interchanged and turned end for end without affecting the work at all, because their accuracy is individually positive, and not relative, one to the other.

J. R.

THE INTERNATIONAL EXHIBITION OF 1876.

SAW-MILLS.

THE circular saw-mill of to-day is in a high state of development, and, indeed, there seems to be little room for any great improvement of the machine, as now manufactured at first-class establishments. The practice of the leading manufacturers of this country and a single Canadian builder is well illustrated at the Exposition; and the two annexes devoted to the display of saw-mills should be thoroughly inspected by all who are interested in the lumber business. The visitor will find most of the exhibits in charge of courteous and intelligent attendants, to whom the writer wishes to render his acknowledgments for the kindly and thorough manner in which his desire for information was met. An attempt is made in this article to give a brief description of the leading characteristics of each mill, as far as they can be rendered intelligible without the aid of engravings. While it is possible that no single mill on exhibition would be considered perfect by the over-critical lumberman, the most particular sawyer could doubtless construct a machine to suit his taste, by using separate parts of the different exhibits, and it may be useful to class the prominent features of each. As a general thing separate portions can be purchased by those who do not desire a complete mill, and this classified description may be of service to some who wish to improve old mills. For instance, a new set of head-blocks, carriage irons, dogs, or the like, may sometimes be used to advantage on an old-fashioned mill, the other parts of which are too good to throw away. For convenience of reference, a list of the exhibits is given below, numbered in the order of their arrangement in the annexes, and these numbers will characterize them in the following description:

CIRCULAR MILLS IN SAW-MILL ANNEX.

1. Lane Manufacturing Company, Montpelier, Vt.
2. Stearns Manufacturing Company, Erie, Pa.
3. A mill without attendance, not completely set up, and exhibitor's name not given.
4. Chase Turbine Manufacturing Company, Orange, Mass.
5. Waterous Engine Works Company, Brantford, Ontario.
6. Reliance Works, Edward P. Allis & Co., Milwaukee, Wis.
7. Lane & Bodley, Cincinnati, Ohio.

IN A SPECIAL ANNEX.

8. E. W. Ross & Co., Fulton, N. Y.

A band-sawing machine, with a saw 9 inches wide, exhibited by C. Meiners, of Philadelphia, is not completely erected, and can be better described on some future occasion. About the middle of the saw-mill annex, the visitor will find the Pacific Coast Steam Logging Saw, exhibited by S. Schofield, of Providence, R. I. This is a cross-cut saw, joined by connecting-rods and cranks to the shaft of what seems to be a small rotary engine, evidently intended to create a commotion when put to work among the trees. There are a few other exhibits of special sawing-machines in this annex; but it may be well to return to the description of circular mills.

MANNER OF DRIVING THE MILLS.

Mills 5, 6, 7, 8 are represented with the engines such as are ordinarily furnished to drive them, and the others are connected by belts to the line shafting in the annex. The different methods of connection with the engine seem worthy of a few remarks. A common arrangement is to belt from the band-wheel of the engine to the pulley on saw arbor, and this plan is adopted in 7 and 8. In two-story mills, where the driving machinery is below and the mill above, it is not uncommon to drive from the engine to a countershaft, and from the countershaft to the saw. This is the arrangement of No. 6. No. 5 presents a somewhat unusual connection, the saw arbor being a continuation of the engine shaft, so that the engine makes as many revolutions as the saw. It is evident that the more direct the connection is made, the smaller will be the engine that is required, and the less the outlay for belts. On the other hand, there are some advantages, in the opinion of many, in an engine working at a moderate speed, even if it must be larger. Below are the dimensions of the engines:

5. Revolutions of engines and saw per minute, 500 to 600. Cylinder, 8½ x 10. Diameter of saw, 54 inches.
6. Revolutions of engine per minute, 125. Revolutions of saw per minute, 750. Cylinder, 16 x 24. Diameter of saw, 56 inches.
7. Revolutions of engine per minute, 180. Revolutions of saw per minute, 700. Cylinder, 10 x 20. Diameter of saw, 54 inches.
8. Revolutions of engine per minute, 200. Revolutions of saw per minute, 500. Cylinder, 10 x 10. Diameter of saw, 54 inches.

The engine exhibited in connection with this saw-mill is manufactured by B. W. Payne & Co., Corning, N. Y. The other engines are furnished by the builders of the respective mills.

SAW-FRAMES.

When large or crooked logs are common, it frequently happens that a large saw is necessary in squaring the log, which can afterward be cut up into boards with a saw of comparatively small diameter. In such cases, it may be advantageous to use a double mill, having a top saw which can be put in motion when necessary. Both single and double mills are represented among the exhibits, but probably any of the manufacturers would furnish either style to order. So, also, both wooden and iron saw-frames are exhibited, and either kind would probably be supplied to a purchaser, as desired. It seems to be a disputed question among lumbermen as to which kind of frame is best, especially for a portable mill; and the writer's experience leads to the belief that either will answer very well.

TRACK IRONS.

The old saw-mill carriage had small pulleys, guided on one side on a V-shaped track, and usually constructed with such insufficient bearings and such imperfect facilities for lubrication that a carriage running properly after a little use was the exception rather than the rule. The modern mill shows a great advance on the old practice. If small pulleys are used, they are generally placed on the ways, where they can speedily be inspected and lubricated, and the tracks are secured to the carriage. This is the plan adopted in mills 1 and 7. Mills 3 and 4 have small pulleys on the carriage, not showing a very decided improvement on old practice. The remaining exhibits have pulleys of large diameter on the carriages, with large bearing surfaces in the journals, and mills 2 and 5 have, in addition, V-shaped guides back of the pulleys on one side, fitting over the track, to aid in keeping the carriage in line. In setting the track, or adjusting the saw arbor, it is usual to allow a little offset, so that in gigging back the saw will not strike the log; and no first-class mill of the present day turns out lumber marked by return strokes, so to speak, of the saw.

MOTION OF CARRIAGE.

In feeding the lumber to the saw, the old clutch motion is discarded, and all the mills on exhibition use the friction feed, in which a small pulley on the feed-shaft is pressed against a pulley on the pinion-shaft, commonly called the rag-wheel, and so communicates motion to this shaft by the friction between the two pulleys. In all the mills the rag-wheel is of cast-iron, and the friction-wheels on feed-shafts of Nos. 1, 2, 5, and 6 are covered with paper; those of 4 and 8 are made of wood, No. 3 has an iron friction-wheel and that of 7 is covered with leather. Most of the mills have cone pulleys on feed-shaft and saw-arbor, so as to change the feed at pleasure; but 2 and 6 have unusually wide feed belts and single pulleys, so that a change of feed is produced, when desired, by allowing the friction-wheel to slip somewhat. It may be remarked that mills 2 and 6, especially the former, are noticeable for the wide belts used, apparently of ample width to force the saw up to full capacity, if sufficient power is employed. The same lever that is used to apply the friction feed, if moved the other way, brings into operation the mechanism for gigging back, in all the mills, either by tightening a belt from saw-arbor to pinion-shaft, bringing a friction-pulley into contact with rag-wheel and outside of saw-belt, or making contact of a friction-pulley with the rag-wheel and a pulley on saw-arbor, all these methods being illustrated in the different mills.

HEAD-BLOCKS.

It is in the set-works of the various mills that the greatest ingenuity and inventive skill are displayed, and no one, whether a professional sawyer or not, can well fail to be interested in witnessing the motions and examining the details. It is feared, however, that the description can not be made very intelligible without the aid of illustrations. The principal objects sought to be accomplished with all the set-works on exhibition, and the methods employed for the same, are as follows:

1st. To arrange the head-blocks, so that they can all be set up the same distance, by the movement of a single lever, or so that one can be advanced farther than the others, if necessary, as in the case of a crooked log. Two general systems of producing this effect are illustrated in the saw-mill exhibits. In one plan, the uprights of the head-blocks are secured to a plank which slides upon the head-blocks, the latter having racks upon them, into which are geared pinions on a shaft attached to the plank, so that by turning this shaft, the uprights are caused to advance. If it is desired to throw out one portion of a log farther than the rest, a lever on the upright at that point is moved, which advances a sliding piece, and it is held in position by a pawl on the lever which moves on a toothed arc. This is the plan adopted with mills 1, 4, and 5, No. 1 having, in addition, a lever near the front end of the carriage, by means of which the sliding-piece can be thrown out on a distant upright. The head-blocks being placed quite close together, with this form of set-works, long or short logs can be sawed with equal facility.

In the other form exhibited, two or more head-blocks are used, and they are so connected by gearing or rack-work that the uprights all advance together when a single lever is moved, while all but one can be thrown out of gear at pleasure, so that only the one remaining in gear will be influenced by the movement of the lever. After the log is squared, it is of course necessary to have all the uprights in line, and the one that has been advanced must be brought back to the same distance from the end of the head-block as the others. Mill 3, as far as could be observed, has no arrangement for moving one upright independently of the others. With mills 1, 4, and 5 it is only necessary to release the lever which throws out the sliding-piece from the upright. As the uprights of No. 2 are moved forward, spiral springs on the connecting-shaft are coiled, so that if one upright has been advanced beyond the others, on releasing a catch it will spring back to its proper position in line. In No. 6, the upright that has been advanced is brought back by a lever, there being a stop for the lever, so as to leave this upright in line with the others. With the other mills, each head-block can be moved back independently by a hand-wheel, and its proper position ascertained by means of figures in the head-block. It may be added that the head blocks of all the mills are marked off in inches and fractions. The head-blocks of No. 2 are "winged," or spread out so that it will take a considerable length of the log.

2d. To arrange the set-works so that lumber of any desired thickness can readily be sawed, the log be set without calculation, and the uprights quickly adjusted for a new log.

To regulate the movements of the uprights by that of the controlling lever, the latter either engages more or less teeth of a wheel in its movement, or has its throw altered by regulating stops. In mills 1 and 5, there is an upright roller on the front of the saw-frame, which can be moved over a scale to any desired distance from the saw; and if the log is brought up against it each time the carriage is gigged back, the next cut will take off a board of the requisite thickness. In No. 8 there is an automatic setter, by which the log is moved out the required distance as it advances towards the saw.

After a log is cut up, it becomes necessary to run back the uprights, and of course it is advantageous to perform this operation as quickly as possible. In Nos. 1 and 6, the sawyer presses a lever as the carriage is running back after the last board is removed, and brings a friction-wheel into gear with a wooden slide, which runs the uprights back as far as is requisite. The spiral springs already mentioned in connection with the set-works of No. 2 draw back the uprights instantly, on releasing a catch, the distance to which they are moved being regulated by racks, at any teeth of which the uprights can be stopped. In mills 3, 4, and 5, the reverse motion is imparted to the uprights by means of the same lever which moves them forward; and in the other two, each upright is run back by an independent hand-wheel.

By constructing the teeth of the setting-wheels so that they move by regular fractions of an inch, whenever a log is squared the uprights can readily be adjusted so that it will be sawed up into an even number of boards, all of the same thickness.

3d. To provide efficient means for holding the log while it is being cut up.

In No. 1 there are heavy dogs on upright screws, which can be run into the log by hand-wheels; and dogs for holding the last board are attached to several of the uprights. Similar last-board dogs are shown with mill 3. The uprights of No. 2 carry a number of dogs hung on pins, one of which will take a log of almost any size, the others turning out of the way, and the one that takes being forced into place by the action of a long lever. For the last board a number of short carved dogs, that are ordinarily flush with the front surface of the uprights, are thrown out and made to engage the lumber by the action of a lever. No. 4 has heavy dogs sliding on upright shafts, which are forced into the log by allowing them to drop, and by reversing them they secure the last board. No. 6 has short curved dogs which can be thrown out some distance in advance of the upright, and on moving a lever they are forced into the log, and draw it towards the uprights. For the last board, these dogs are drawn back so as to be almost flush with the uprights, and are then forced by the lever into the log. Back of the uprights on mill No. 7 are heavy curved dogs, which can be turned round into any desired position by hand, and revolved downward into the log by a hand-wheel. No. 8 has heavy dogs, which are forced into the log by a long lever, and this mill has an arrangement by which a log can be dogged both above and below, and raised up clear of the head-blocks, thus being held securely for sawing through and through without squaring. Several of the mills have under dogs, for the purpose of securing crooked or springy logs.

DEVICES FOR TURNING THE LOG ON THE CARRIAGE.

There are numerous arrangements of this kind in common use, but only two are shown at the Exhibition. Both of these, however, will probably present novel features to many lumbermen. In mill No. 2, by pressing a lever, a toothed wheel rises from the log-deck, and its teeth engaging the log on the carriage as it revolves, the log is turned into any desired position. No. 6 has a lever on the carriage, with a dog at the end, and this being forced into the log, the latter is forced to revolve by the movement of the lever.

LOG-HAULER.

In connection with mill No. 2 there is shown an arrangement for hauling logs out of the slip, consisting of an endless chain running down into the water, and constantly in motion. Having driven a dog into the log, it is only necessary to hook this to the endless chain, and the log will be hauled up, all necessity of carrying down the chain for each log being obviated. No. 6 has a car running on a track, upon which the log is hauled up by means of a rope or chain.

In order to keep this communication within proper limits, it has been necessary to omit many interesting details; but it is hoped that the reader will be able to form some idea of the prominent characteristics of the different mills on exhibition. It only remains to say that if any one is thinking of purchasing a saw-mill, he will find the two annexes at the Exposition excellent places in which to make his selection.—*Railroad Gazette.*

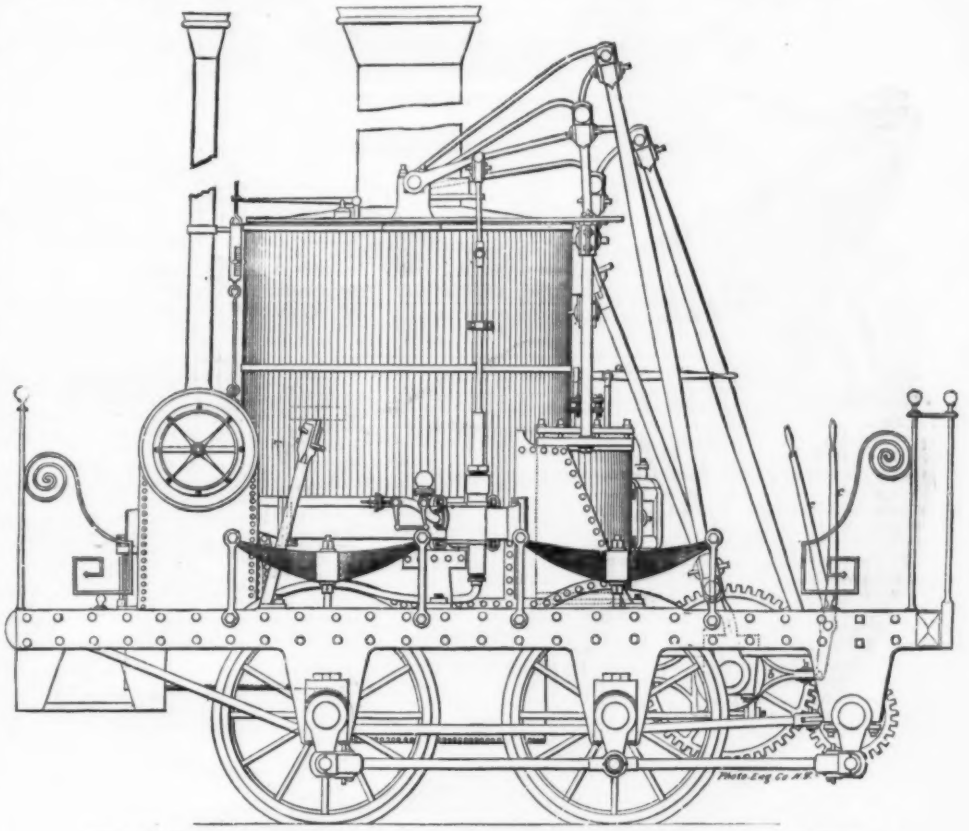
LOCOMOTIVES AT THE PHILADELPHIA EXHIBITION.

OUTSIDE the Maryland State Building at the Philadelphia Exhibition, stands engine No. 6, of the Baltimore and Ohio Railroad. We publish an engraving of this engine as manufactured in 1835 by Gillingham & Winans, at Baltimore. The advantages claimed for this engine at the time it was built were—1. The use of anthracite as fuel; 2. The vertical tubular boiler; 3. The use of the adhesion of all the wheels. The general construction will be understood from the view given, but unfortunately no sectional drawings exist. The engine stands upon four-coupled wheels 36 ins. in diameter, and placed 4 ft. apart. The frames are of wrought iron, and extend considerably beyond the wheels at each end. At the rear two horn-plates are attached to the frames as shown, these horn-plates carrying the bearings of the pinion shaft, which is provided with a crank at each end, connected by coupling rods to the driving wheels. Between the frames at the forward end there is a fireman's foot-plate. The boiler is vertical, 52 ins. in diameter, and contains 400 tubes, 1 in. in diameter, and 3 ft. 2 ins. long. These tubes are attached at the upper end to a tube-plate forming the bottom of the uptake, and leaving 2½ in. water space between it and the boiler shell, and at the bottom the tubes are connected with the crown sheet of the firebox. The boiler is externally fired—that is to say, there is a D-shaped furnace projecting from the boiler, and extending into the cylindrical firebox within. The door of the furnace is almost on the level of the fireman's foot-plate.

The engine originally, and till a comparatively recent date, carried a fan driven by the exhaust steam, which finally escaped up the small chimney. This is a contrivance which has been re-invented of late years. The fan has, however, now disappeared, and is replaced by the blast nozzle. The steam is led to the cylinders down the inside of the boiler by a channel made of thin plate riveted to the latter. The connection with the steam pipes is made about the middle of the length of the boiler, *a* being the throttle lever. There are two vertical cylinders, 10 ins. in diameter and 24 in. stroke, secured to the framing as shown; the piston rods actuating the two cast-iron vibrating beams, which have their bearings on the top of the boiler. The connecting rods at the ends of the vibrating beams take hold of the crank at the end of the spur-wheel shaft as shown, and so through the pinion communicate motion to the wheels. The original spur-wheel is in use upon the engine exhibited, but new pinions have been added on several occasions, as more power was required at the expense of speed.

The valve motion is very simple. On the spur-wheel shaft are four cams, two on each side of the spur-wheel, one pair corresponding with a forward and the other pair with a backward motion. The valve spindles are connected to a way shaft extending across the machine, and to this are also attached by links the ends of two spindles terminating in open straps (*b*) which pass over the cams. By throwing over the levers *c c*, an operation assisted by foot levers, the straps are thrown over the forward or backward cams at will, and the motion of the machine is regulated accordingly.

The weight of engine and tender is 7 tons 5 cwt., empty, and the capacity of the latter is equal to 4000 lbs of coal and 750 gallons of water. This engine and seven other similar ones have, since they were built, been in constant service upon the Baltimore and Ohio Railroad; some slight alterations have been made in them, such as the removal of the fan, and the addition of an injector, but beyond these the principal change is in the use of larger pinions to reduce the speed and gain power, which was required when the engines came to be employed as shunting and yard engines. As regards workmanship they reflect the highest credit upon the builders; and the fact that they have been forty years in constant service, and the original mechanism is still driven with 70 lbs. of steam, is the best test of this.—*Engineering.*



THE INTERNATIONAL EXHIBITION OF 1876.—FORTY-YEAR-OLD LOCOMOTIVE.

THE CORLISS BEAM ENGINE AT THE EXHIBITION.

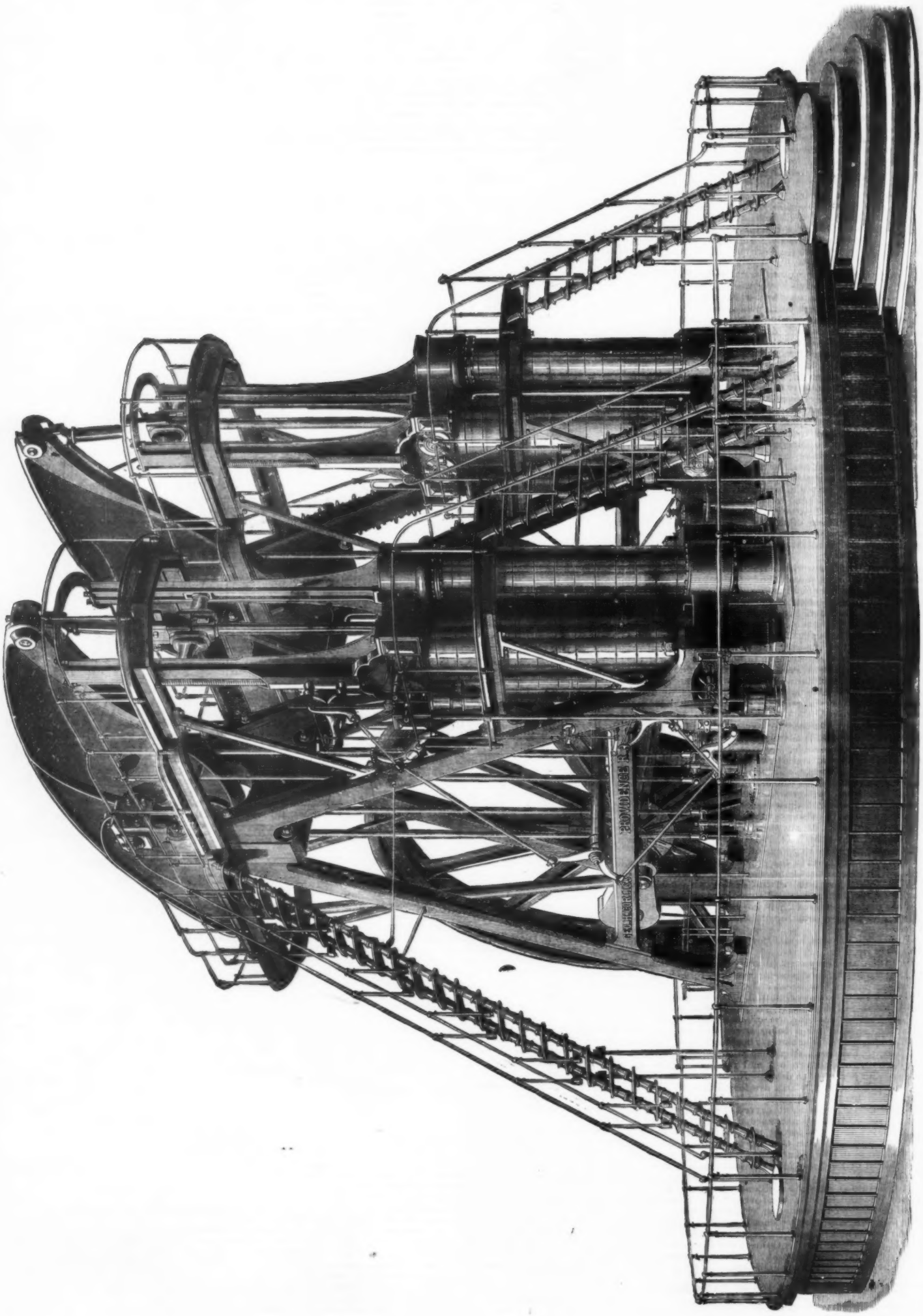
ON pages 402-3, Vol. I., of our SUPPLEMENT we have given perspective and plan views of the great Corliss beam engine, erected by Mr. Geo. H. Corliss, at the Exhibition, to drive the machinery in the Machinery Hall, and we at the same time described the construction of the engine and the arrangement of the shafting connected with it. We, however, think that many of our readers will be interested in examining the additional perspective view of this engine, which forms a page plate this week, and for which we are indebted to *Engineering*. This view, which has been prepared from a photograph, gives an excellent idea of the general appearance of the engine and of its enormous size. For convenience of reference, we repeat some of the principal dimensions:

	ft.	in.
Diameter of cylinders	3	4
Stroke	10	0
Diameter of piston-rods (steel)	0	6¼
Speed, 36 revolutions per minute, corresponding to a piston speed of 720 ft. per minute.		
Length of beams	27	0
Depth " " at centres	9	0
Weight of each beam	11 tons	
Length of fly-wheel shaft	12	0
Diameter of " "	1	7
" " " " at bearings	1	6
Length " " " bearings	2	3
Diameter of fly-wheel	30	0
Width " " across the face	2	0
Number of teeth on fly-wheel	216	
Weight of fly-wheel	56 tons	

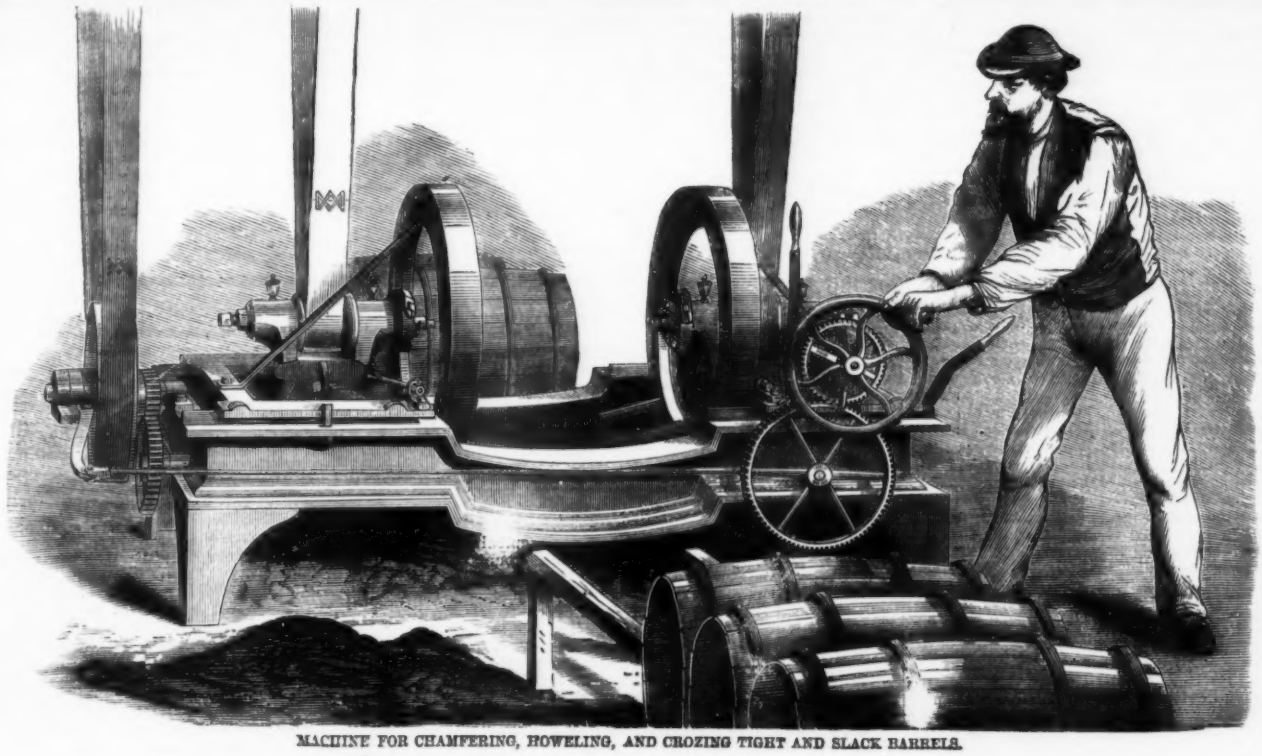
The pair of engines are rated at 1400 horse-power nominal collectively, but they are capable of indicating 2500 horse-power.

A LOST ART IN SURGERY.

DR. H. B. CROSBY lately read a paper before the New York Medical Society, taking for his subject, "A Lost Art in Surgery." The lost art referred to by the reader of the paper was surgical cleanliness. In the course of his remarks he mentioned the method of purifying those wards of Bellevue Hospital, which were infected by the last epidemic of puerperal fever, and which was so thoroughly performed that, on their subsequent occupation by surgical cases, much less than the usual tendency to pyæmia and septicæmia was observable. The system of disinfection consisted in closing the ward, and charging it with steam. Afterward large leaden troughs were placed on the floor, and a sufficient amount of chloride of sodium, black oxide of manganese, and oil of vitriol added to disengage enough chlorine gas to thoroughly charge the ward.

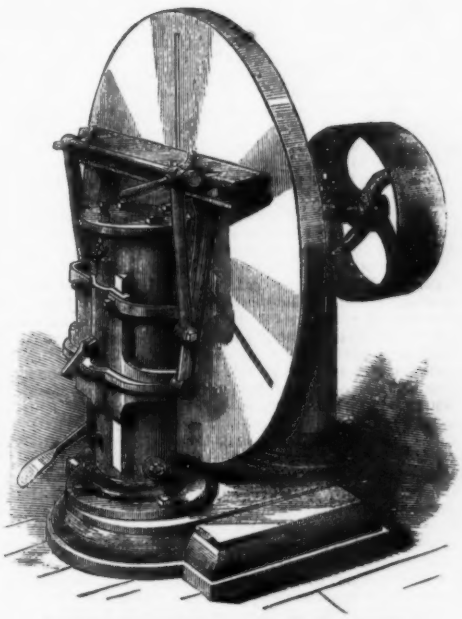


THE INTERNATIONAL EXHIBITION OF 1876.—THE CORLISS BEAM ENGINE. (See page 561.)

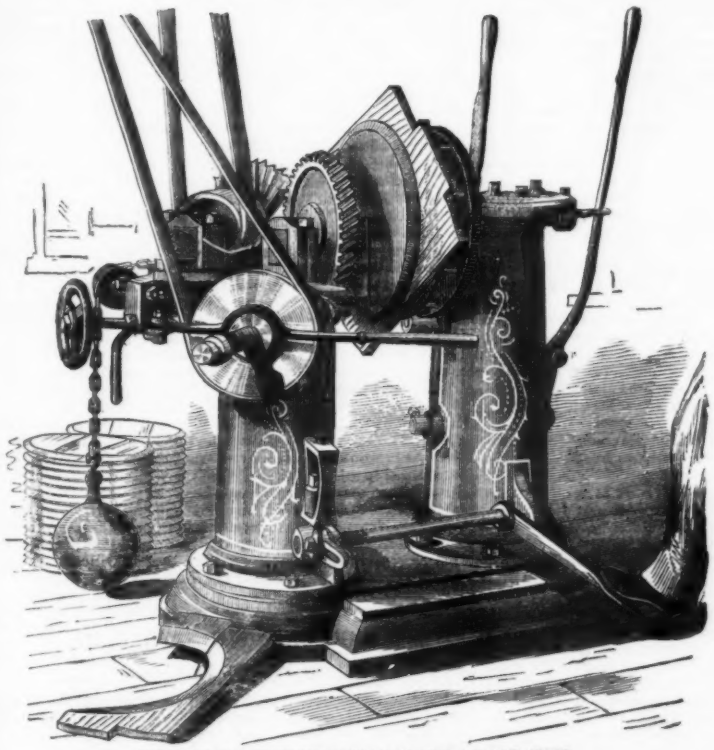


MACHINE FOR CHAMFERING, HOWELING, AND CROZING TIGHT AND SLACK BARRELS.

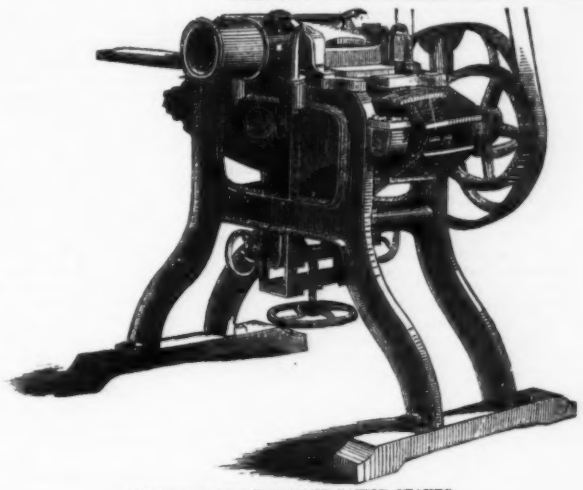
MACHINE FOR TRUSSING TIGHT AND SLACK BARRELS.



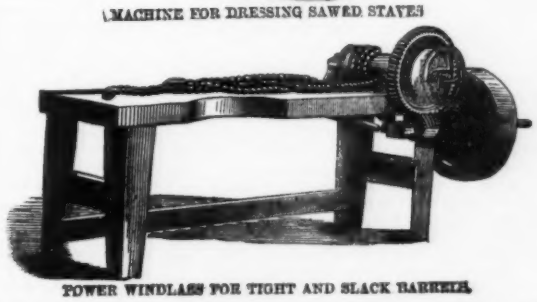
WHEEL JOINTER FOR SLACK BARREL STAVES



MACHINE FOR TURNING BARREL HEADS OF ALL SIZES.



MACHINE FOR DRESSING SAWED STAVES



POWER WINDLASS FOR TIGHT AND SLACK BARRELS.

THE INTERNATIONAL EXHIBITION OF 1876.—BARREL-MAKING MACHINERY. (*See page* 564.)

BARREL MACHINERY AT THE EXHIBITION.

A VERY interesting exhibition is that of Messrs. E. & B. Holmes, of Buffalo, N. Y., who show four sets of barrel-making machinery in operation, making tight and slack barrels of different sizes. The first operation consists of sawing off the staves to the required length, by means of two circular saws set on one spindle, with the proper interval between them; the staves are then passed through a machine which dresses both sides of them simultaneously. The jointing of the staves and cutting them to the requisite curve is performed by holding the stave against the side of a revolving concave wheel furnished with a radial cutter. The staves are then placed in a setting-up frame, which retains one end of the staves in position; the barrel is then conveyed to a windlass machine which draws the other end of the staves together by means of a wire rope passed round them, and a hoop is then dropped over them. The barrel is then placed over a stove and heated inside, and then the hoops are forced on by a dressing machine. The next operation is performed on a working-off machine, where the exterior of the barrel is smoothed and the grooves and bevels for the reception of the heads are cut. The heads are jointed on a wheel and planed on one side only, and are then turned and chamfered. A machine is also shown for cutting shingles or barrel heads, and for punching and riveting iron hoops at one operation. Wooden hoops are still made by hand. The set of machines thus briefly described is for making light barrels for containing liquids, and will turn out 500 barrels per day with one man in charge of each tool. The tools for constructing slack barrels for solids and small kegs are upon the same principle with modified details. A more full description of these machines, with additional engravings, will be found in the SCIENTIFIC AMERICAN, beginning in May of present year

A TRIBUTE TO PROF. F. REULEAUX,

COMMISSIONER-GENERAL OF THE GERMAN EMPIRE.

ON the evening of the 15th ult. the German representative gave a banquet to the Centennial Judges and Commissioners at Lauber's restaurant in Fairmount Park, the entertainment being one of the series of international hospitalities which have followed each other so swiftly and pleasantly this season. The especial occasion was the early departure for home of Prof. Reuleaux, that distinguished gentleman being needed in Berlin to complete the intended consolidation of the three leading academies of that city into one great educational system. Having presided with rare ability over the Polytechnic, he is peculiarly qualified to direct this important work to a grand consummation. Possessed of that personal magnetism which lends earnestness and intensity to his character, whether in the department of investigation or of friendship, the guests present, native and foreign, experienced peculiar pleasure in doing him honor, and were earnest in expressions of regret that circumstances should call him hence so soon.

There were some pleasant speeches, in which his associate Commissioners bore testimony to the untiring zeal and efficiency of his labors in Exposition matters, and to the cordiality and unity of their relations together, and some modest but manly words in which Mr. Goshorn and Gen. Hawley claimed that the blossoming results of the Centennial were already justifying and rewarding the labors of the earlier days, when failure was so gloomily predicted by the many. It certainly is to be hoped that our American people will not forget, now that the success of the undertaking in the highest sense is demonstrated, that but four months ago it required on the part of their Commissioners not only unusual executive ability to prepare for it, but distinguished courage to compel it.

Let those hard-worked and little-thanked gentlemen not fail of their laurels—small wages for so great services But to Prof. Reuleaux is just now due special praise for having taken a brave stand upon the very point which is vital to the attainment of the noblest results possible to the Exhibition. He has dared to criticise boldly the deficiencies of his own nation's exhibits, and straightway the German manufacturers who are hit by his strokes cry out on him as if he had committed treason against the State. This clamor is not strange, but it is curious to see a neutral, through the columns of so influential a journal as the *Engineer*, beginning a leader with such words as these: "The Centennial Exhibition, so far from fulfilling the peace-bearing part designed for by its promoters, seems likely to be associated with little else than discord and melancholy reflections on all sides. In its own country it has long been a subject of contention between bitter, quarrelsome parties, and now it has indirectly furnished a text to a well-known German authority, Professor Reuleaux. In the discharge of his duties he has of course made a careful inspection of the exhibits in the German department, and in a letter to the *National Zeitung* he has condensed his views, as the *Times* correspondent remarks, into three condemnatory sentences, one more crushing than the other."

What, we would ask, is the object of this great international display? Is it a vast show wherein each exhibitor is to strut, satisfied of the superior excellence of his wares, and to decry his neighbors'? Is it a world's mutual admiration society? Or is it a colossal school wherein the nations have met to learn of each other, and by intelligent comparison of the products of their various industries, and by a fearless criticism of deficiencies, and a generous acknowledgment of excellences, reach forward to higher standards in every department of civilization? This appears to be Prof. Reuleaux's view of it, and we are in full sympathy with him and do him honor for the trumpet note which he has sounded. And we make issue with the *Engineer* as to its being a signal to battle. It is a call for a more earnest pursuit of peace and to greater victories in the paths of art and industry. Our cotemporary seems to catch the inspiration, for before closing the article he admits that the German Commissioner's strictures apply with force to English manufacturers, and from the same text he preaches a sermon to his countrymen. We consider it a very proper theme at this time for all the nations, our own included. The tendency of prosperity has been toward a degeneracy in industrial products, the well-to-do purchaser becoming indifferent as to the quality of the thing bought, and the maker of it proportionately careless in its manufacture. There are undoubtedly great material as well as moral advantages to grow out of such periods of universal commercial depression as the world is now experiencing. The hot haste which tends to neglect and waste is checked, and with less demand for his goods the manufacturer has time to use more care—in fact, is compelled, by greater excellence of workmanship, to attract attention and secure traffic. Even among the leading and most beautiful industries of the United States, processes have been and still are employed which are extravagant in the extreme; and if the stagnation which hangs over them to-day results in the development of more economical methods, it will yield a future profit worth all our present pain.

The opportunity for study afforded by the Exhibition is therefore very timely. When we learn to make things thoroughly good, there will be no trouble about their sale, and far less danger to our overtrading, to which we may safely attribute our present financial distress. This we understand to be the spirit of Prof. Reuleaux's criticisms, and we insist that instead of being charged by his countrymen with disloyalty, he has illustrated by his frank words a noble devotion to the best interests of Germany, and a courage superior to that which might have led him to battle with a foreign foe. To quote his own language, "Truth, if sometimes unpalatable, is always wholesome." As Americans, we honor him for his words to his countrymen, and accept his teachings for ourselves as well.

We repel the assertion of the London *Engineer*, that "the Centennial Exhibition, so far from fulfilling the peace-bearing part designed for by its promoters, seems likely to be associated with little else than discord and melancholy reflections on all sides." In the very highest sense it is fulfilling that noble purpose.

It was not a mere transient sentiment, born of a good dinner, that led Governor Hawley, after singing the "Wacht am Rhein," hand in hand and face to face with Professor Reuleaux, to say, "It is such occasions as this that enable the nations to sing in chorus and friendship each other's war songs."

G. S. D.

APICULTURE AT THE CENTENNIAL.

By R. MCKEAN JONES.

IN the Agricultural Hall, where most of the apicultural display is, stands a neat show case full of White Mountain comb honey, in the well-known frames of J. S. Harbison, of San Diego, California.

The only exhibit made by any American bee-keeper, with the exception of the above named, is that of J. S. Coe, of New Jersey, which is yet in an unfinished state. Mr. Coe has erected a neat bee-house about midway between the Dairy Building and the Brewers' Hall, a little to the east of the Agricultural Hall. It is constructed in the form of a rectangle and has a sloping roof. It has doors at each end, and shelves for the hives running lengthwise, so that when it is fitted up visitors can pass right through it, inspecting the hives on the shelves on either hand; the entrances for the bees are through the side walls. Mr. Coe is the sole representative of American apiculture upon the ground.

On the eastern side of the main aisle of the Agricultural Hall, near the main or southern entrance, is the stand of Geo. Neighbour & Sons of London, which is by far the largest and most complete of any show at present in the Exhibition. The goods on this stand fully illustrate the state of apiculture in England. They exhibit a large model of their unicomb hive, very neatly made and finished. The peculiarity of this hive is, that instead of ranging the frames side by side, as done in American hives, they place four together, as if to form one large frame; or, as the name implies, to make but one sheet of comb in the hive. There is also a large model of a cottager's frame hive, with the frames ranged side by side in the usual manner. The exhibit of their straw hives is very complete, showing the different sizes and styles of the improved straw skeps: these comprise their improved cottage hive, with doors to permit the inspection of the interior; the Crystal Palace prize skep and several other kinds; and a stock hive constructed of wood and straw quilting. Among the numerous feeding bottles and feeders exhibited, the most noticeable is their improved zinc feeder. This is a shallow zinc pan about one and a half or two inches deep, with a piece of pipe set in the centre to admit the bees from the interior of the hive through; the pan contains a perforated wooden float, and the whole is covered with a sheet of glass. A box of artificial comb foundations, or as they are there termed, impressed wax sheets, is among these exhibits; they are, as has already been acknowledged, much inferior to those manufactured here. The plates by which these are made are also shown. A close examination reveals the fact that they have no depression between the dies, consequently the sheet has the bottom of the cell only impressed upon it, instead of having a shoulder like the foundations of American manufacture. The process of making wax guides for the apiary is illustrated by a model with drawings and letterpress description, and a sample of a very perfect plaster cast.

A. C. Atwood of London, Ontario, displays his improved Thomas hive among the Canadian exhibits. This is a very handsome hive, having two stories of frames set in notched rests to keep them in place, and furnished with movable division boards for contracting or dividing the hive. It is very substantially made and handsomely painted. The price marked on the exhibitor's ticket is ten dollars. Mr. Atwood also exhibits a large honey extractor—the only one shown, by the way; it is cylindrical in form and stands on a strong iron tripod; the frames from which honey is to be extracted are placed in a large wooden box with coarse wire sides; a pole passes perpendicularly through this box, and is actuated by a small bevel gear and crank at the top. It gives an exceedingly rapid and steady motion, and may be used as a tank when not otherwise in use, as it is furnished with a patent gate at the bottom of the cylinder.

The display of beeswax is much larger than that of anything else connected with an apiary, although it is scattered so that it does not make much of a show.

In the Agricultural Hall, J. Fritsch, of Carlstadt, New Jersey, makes a display of beeswax. He shows the yellow wax flaked in readiness for bleaching; also as it appears when ready for sale. In addition to this he has a number of articles manufactured from the refined wax, such as candles, tapers, and a variety of fancy boxes and baskets made entirely of white wax.

E. E. Visser, of Amersfoort, in Holland, makes the largest display of yellow wax; it comprises several huge cakes of a very fine quality and color of beeswax.

Among the agricultural products of Italy is a cake of yellow virgin wax, exhibited by the Baron Siacca della Scala, from his apiary at the farm of Scala di Patti, in Italy.

In the British department of the Main Building, J. C. & J. Field, of London, make a very handsome display of wax in almost every conceivable form; their display of wax candles and tapers is well worth notice.

In the Austrian department stands a case containing a huge pyramid of what looks like beeswax, but really is a mineral wax best known under the name of ceracine. It is manufactured by H. Ujhely & Co. of Stockerau, and is used for many purposes for which beeswax was formerly thought indispensable. This exhibit will well repay an inspection, as it reveals how very closely the genuine product of the apiary can be counterfeited, for in this case may be seen cakes of yellow and white wax that not one person out of a thousand would take to be other than genuine beeswax.—*Bee-Keepers' Magazine.*

CONCRETE FLOORS.

MR. A. C. PONTON, writing to *The Building News*, says:—At a time when so much attention is being called to the construction of concrete plate floors, and when it is considered that this method of construction will be largely used, it is well to point out those principles upon which safety of the structure depends. The first point to bear in mind is that carefully-prepared concrete, under stress, bends in the same uniform way as glass, marble, slate, and other such ones, and that each of these substances will go through a definite angle, when exposed to a transverse strain, before rupture takes places. This angle does not vary nearly so much in one specimen from another of the same material as does the strength. With two specimens of the same material, one half the strength of the other, the angle of rupture may yet remain the same. From this circumstance, in floors constructed in concrete, by far the safest test is to measure the angle produced by any stress, and then if the ultimate angle of rupture is known, a ready means will thus be given for ascertaining the safety or otherwise of the plate floor. There is no practical difficulty in accomplishing this measurement. From my own experiments I have ascertained that the ultimate angle for cement and cement concrete varies between 6 and 8 minutes of a degree in a bar 1 ft long, 1 in. square, supported at the two ends—in other words the total deflection does not exceed $\frac{1}{1000}$ of an inch. It of course takes very different stresses to produce this ultimate angle. With pure cement a weight of 1 cwt. in the centre would be required, whereas with cement concrete a weight of one quarter of a cwt. would produce the same angle of rupture.

To test a plate floor the angle of rupture must first be ascertained, and although experiments upon bars enable us to make a rough computation of about the angle of rupture, still it would be much better to have accurate tables made from direct experiments upon plates fixed at the edges, so that these tables might be used in the computations. If we know the angle of rupture for the plate floor it becomes a mere question of the ordinary principles of construction to take one fourth of the total angle for the limit of safety when the plate floor is fully loaded, allowing the remaining three fourths for extraordinary cases of concussion. In the first stages of this new method of construction it would be safer to take one sixth the total angle, because the angles which have to be passed to produce rupture with a concussion are very small indeed.

Knowing the angle of rupture, if a weight of 2 cwt. is placed in the centre of the plate floor, and the angle is measured with a delicate instrument, first with the weight on and then with the weight off, it is easy to note what proportion the observed angle bears to the ultimate angle, and this proportion indicates the breaking stress.

The instrument which I have used in my experiments will indicate the angles amounting even to the one sixtieth of a second of a degree, this large amount of magnification being required owing to the very minute strains which are produced in concrete under stress.

The concrete floor described by your correspondent which gave way at Portsmouth was no doubt owing to the concrete not being set, and the ballast being of that description which does not produce a fairly homogeneous concrete, or one with a high transverse strength. It is of the first importance to make experiments upon the hardness of the concrete floors before the centreing is struck. The best means to accomplish this would be by means of an instrument arranged like a pile-driving machine—that is with a galling weight upon a bolt, and to notice the depth to which the bolt penetrates into the concrete. This experiment could be tried upon different parts of the floor at different times; and a little practice would soon indicate when the concrete was sufficiently set. I look forward with confidence to the period when concrete plate floors will be used with as much safety and certainty as wrought iron; but this result can only be accomplished after careful investigation of the bending properties of concrete, and by subjecting each floor to some inexpensive system of testing.

STEEL-WIRE HAWSERS *v.* HEMP HAWSERS.

AN important trial lately took place, by order of the Lords of the Admiralty, at Devonport Dockyard, conducted by Capt. Youel, the Master Attendant, and witnessed by Admiral G. O. Willes, C.B., and other officers of the yard. It is the custom at the Government dockyards to keep in store 25-inch and other large sizes of hemp hawsers for use in cases of emergency, as in the instance of Her Majesty's ship "Agincourt" getting on shore, when these hawsers were sent out to assist in getting her off. In the finest weather, and under the most favorable circumstances, it is with the greatest difficulty these hawsers can be handled. Mr. Bullivant therefore obtained permission of the Lords of the Admiralty to test his 8 inch patent flexible steel-wire hawser of equal strength again the 25-inch hemp hawser, as used in the Service. The 120 fathoms of 8-inch steel-wire hawser tested weighed 50 cwt., and was coiled on a reel, the outside measurement of which was 5 feet square. The 25-inch hemp hawser was coiled in a tier 42 feet long and 14 feet wide, and the weight to 120 fathoms is 150 cwt. Each hawser had an eye spliced in the end ready for use. Twelve men were told off to work the 8-inch steel hawser, which they hauled off, ranged along the ground, with the greatest ease, and two men took two turns round a gun post one foot in diameter, without any injury to the steel-wire hawser. Forty-eight men were then told off to work the 25-inch hemp hawser, the eye and thimble of which were so large and heavy that it was found necessary to provide two large trucks in which to move them; trussels were also laid along, on which the hawser was hauled to a post 18 inches in diameter, round which one turn was taken with difficulty. A wish was expressed by Mr. Bullivant that the hawsers should be put in and laid out from a boat, as it would be necessary to do in case of requiring them to get a ship off the shore. This was, however, considered quite unnecessary, as it had been so clearly shown that twelve men could work the flexible steel-wire hawser far easier than forty-eight men, assisted with trucks and trussels, could work the 25-inch hemp hawser; and it was also stated that no ship in the Service carries a boat in which the 25-inch hemp hawser could be coiled and paid out.

THE COAL OF WEST VIRGINIA.

By Prof. M. F. MAURY.

THE most important coal region in America is the Appalachian coal-field, which is, says Rogers, "almost the largest expanse of continuous coal measures in the world. It possesses a length of 875 miles, and a maximum breadth, between its eastern outcrop in southern Pennsylvania and its western in northern Ohio, of about 180 miles." It extends

from northern Pennsylvania to middle Alabama, parallel to the Appalachian chain to the east of it. Its coals are better than those of any other field in America, and, save anthracite, are of every kind necessary to the arts and manufactures. Its area is made up as follows:

West Virginia	16,000	square miles.
Pennsylvania	12,700	" "
Ohio	10,000	" "
Eastern Kentucky	8,900	" "
Alabama	5,000	" "
Tennessee	5,100	" "
Maryland	550	" "
Total	58,550	" "

Of these the amounts for Pennsylvania and eastern Kentucky are the results of careful surveys, while the others are estimates taken from the best and latest sources.

By the U. S. census of 1870, these States mined the following tonnage:

Alabama	11,582	tons.
Kentucky	150,000	"
Maryland	1,819,824	"
Ohio	2,527,285	"
Pennsylvania	7,798,518	"
Tennessee	133,418	"
West Virginia	608,878	"
Total	12,049,505	"

These tables, therefore, show that while West Virginia embraces (in round numbers) nearly 28 per cent of the coal area, it produced only 5 per cent of the coal mined therein.

In the absence of an abstract and definite location, the eastern boundary of the West Virginia coal-field may be described as follows: Beginning at the south on the mountain just east of Blue Stone River, and proceeding thence to Little Sewell, on the top of which the lowest seam of the lower measures may be seen; thence by, but not a very clearly defined line, with the common boundary of Nicholas and Greenbrier, and Webster and Pocahontas, to Rich Mountain in Randolph; following this last-named ridge to Laurel Mountain, the dividing line between Upshur on the west and Randolph and Barbour on the east; and thence with the Briery mountain into Preston county and on the Pennsylvania line. To the east of this boundary there are small outlying patches of coal, as in Greenbrier in Meadow mountain, and possibly in Pocahontas and in some of the synclinal valleys of Tucker, but they are unimportant as compared with the vast area to the west, and in but few instances will yield fuel of any value except for local use. This remark will not, however, apply to the valuable, though small, trough in Mineral and Grant, which is entirely separated by sub-carboniferous strata from the main West Virginia coal-field.

In every county west of the general boundary to the Ohio river, valuable coal will be found, if not in the hills, then below the surface, and accessible by shafting, so that out of 54 counties in the State, only Monroe, Pendleton, Hardy, Hampshire, Morgan, and Jefferson lack it *in toto*.

THE VENTILATION OF COLLIERIES.

THERE now appears to be a pretty universal preference for the fan as against the furnace for effecting the ventilation of mines. The old-fashioned cupola fire—which is at the present time in operation at hundreds of collieries in all parts of the country—has nowadays come to be looked upon with a great deal of suspicion. Many explosions have inferentially been traced to the fires thus used underground, and others have, to all appearance, been caused in the same manner. Mining engineers putting this and that together some time ago, arrived at the conclusion that it would be better to discontinue the use of all underground fires, which are practically huge, naked lights, provided some equally effective mode of ventilation could be hit upon. With the hour came the man; the necessity brought forth the invention. Several fans for the need thus expressed were invented, and Guibal's, particularly, met with hearty approval. At all the new collieries which have been sunk in Durham, Yorkshire, Northumberland, and South Wales, the fan has been put down, and experiments have been most exhaustively made, the results of which have amply proved the the fan is equal to the furnace. Some experiments of this kind were made last week at the Oaks colliery of Messrs. Charles Cammell & Co. (Limited), near Barnsley, where a new Guibal fan, 40 ft. diameter by 12 ft. in peripheral width, made by Messrs. Davy Brothers, of Sheffield, has just been erected. A number of mining engineers and colliery managers were present by invitation, and they were very well satisfied that the fan is not only infinitely safer, but fully as efficacious as the old furnace. This particular fan, when the engines were running at twenty strokes per minute, withdrew 77,926 cubic feet of air in the same period; at thirty strokes, 107,856 cubic feet; and at forty strokes, 140,694 cubic feet. In a tabulated form the results and conditions under which they were obtained are as follows:

Fan running per minute.	Thermometer.	Water-gauge. Inches.	Cubic feet per minute.
Strokes 20	71 deg.	5-10	77,926
" 30	71 "	9-10	107,856
" 40	71 "	13-10	140,674

The Oaks pits, as all mining engineers know, are very fiery, and exude a great deal of gas.—*The Engineer.*

VANADIUM.

PROFESSOR H. E. ROSCOE, F.R.S., of Owen's College, Manchester, at a recent meeting of the Royal Institution, gave an account or the results of his recent investigations into the properties of the rare metal vanadium. This metal, discovered in certain iron ores by Sefström, a Swedish chemist, in 1830, is named after Vanadis, a cognomen of Freia, the Scandinavian Venus. It was specially studied by Berzelius, who corroborated Sefström's statement that its characteristic feature is an acid-forming oxide, termed "vanadic acid," and discovered other oxides and a volatile chloride. The price of vanadium, £35 the ounce, excluded it from ordinary investigations, till, in 1865, Professor Roscoe obtained a supply, having discovered it in the copper-bearing beds of the lower keuper sandstone of the lower trias at Alderley Edge, Cheshire. He proved, in 1868, that the vanadium of Berzelius is an oxide, not a metal; and determined the atomic weight, from a compound with nitrogen, to be fourteen parts by weight of nitrogen to 51.3 of vanadium; and also proved it to possess close analogies with phosphorus and arsenic, being one of the trivalent group of elements. It has since been ascertained that vanadium has poisonous effects upon the animal system resembling those of phosphorus and arsenic; and that vanadic, like phosphoric, acid has three series of salts—ortho, meta-, and pyro-vanadates—which differ from the phosphates in the order of their stability. Of these the ortho-vanadates were described as highly sensitive to the action of light, and therefore available for photography, of which the Professor exhibited examples Vanadium, he said, may also become valuable in dyeing. In manufacturing aniline black powerful oxidizing agents and high temperatures are required, which tend to destroy the fabric dyed. The Professor stated that the oxidizing power of vanadium very greatly exceeds that of the salts of copper usually employed, and that the aniline black produced by it is permanent; whereas that produced by copper is liable to turn green. Vanadium oxide has already been employed in making marking-ink, seven to twelve grains of the salt being sufficient to produce a gallon of ink, and sixteen grains, costing one penny a grain, are sufficient to print 500 yards of calico. Thus an element which for a long time was only a chemical curiosity has furnished another example of the great importance of original scientific research. The discourse was fully illustrated by experiments and diagrams.

UPWARD AIR CURRENTS.

AT a recent meeting of the Meteorological Society a paper was read "On the Upward Currents during the Formation and Passage of Cumulus and Cumulo-stratus Clouds," by the Rev. Joseph Crompton, M.A., F.M.S. The author, when walking close to the cathedral, Norwich, was struck with the unusual fluttering of the flags on the top of the spire, which is 300 feet high. They were streaming with a strained, quivering motion perpendicularly upwards. A heavy cloud was passing overhead at the moment, and as it passed the flags followed the cloud and then gradually dropped into comparative quietness. The same phenomenon was noticed several times. As the cloud approached, the upper banners began to feel its influence and streamed towards it, against the direction of the wind, which still blew as before steadily on all below; as the cloud came nearer the vehement quivering and straining motion of the flags increased, they began to take an upward, perpendicular direction right into the cloud, and seemed almost tearing themselves from the staves to which they were fastened; again, as the cloud passed, they followed it as they had previously streamed to meet its approach, and then dropped away as before, one or two actually folding over their staves. All the other flags at a lower elevation did not show the least symptom of disturbance.

METALLIC OSMIUM.

AT the session of the Academy of Sciences on the 8th of May, were exhibited several specimens of metallic osmium, prepared by M. Henri Ste. Claire Deville. This osmium is of a blue shade, tinged with gray, showing violet if light is reflected several times upon its surface. Osmium is stated to be the most dense matter known; it is hard enough to scratch glass easily. In the preparation of crystallized osmium, the vapor of osmic acid several times distilled is passed over pure carbon. To get this, benzine vapor is decomposed by causing it to pass over a tube of red porcelain, upon which coherent carbon is deposited as a hollow cylinder The osmic acid vapor is afterwards introduced, carried in by nitrogen. The osmic acid is reduced, giving carbonic acid and osmium, which soon lines the inside of the carbon cylinder, ending by completely transforming the latter into carbonic acid, and depositing the metal. Tubes of osmium are thus produced of a nature analogous to the cadmies of oxide of zinc obtained by burning zinc vapors issuing from a hole in the cover of a crucible in which zinc is boiling.

LARGE PANORAMIC NEGATIVES BY MEANS OF ORDINARY SMALL CAMERA AND LENSES.

By L. WARNERKE.*

WHILE taking negatives on my sensitive tissue in the roller dark slide, it occurred to me to utilize the peculiar advantages possessed by this method, and I submit now to your notice the results of my experiments.

To make my description intelligible, I shortly here say that the roller dark slide is the substitute for ordinary dark slide, having, instead of the usual receptacle for the glass plate, two rollers, on which an endless band of sensitive tissue is wound, an arrangement provided to expose in succession one length of it after the other in the ordinary camera. The tissue itself is flexible transparent film of collodion temporarily cemented to the paper, but detached from it after the negative is developed.

To produce a panoramic negative, I expose the sections intended to form the panorama, separately, by simply rotating the camera round its axis. Care must be taken to have the camera level, and to provide the arrangement to produce the rotation of the camera round the vertical line, passing through the centre of the lens. The lens must be of non-distorting kind, otherwise the line forming the junction between two sections of panorama will be concave on one and convex on the other, and consequently the junction impossible. The horizontal lines, through the same cause, will have the cycloidal shape on the panorama.

The exposure of every section must be strictly identical, and every such section must have a small part (a quarter of an inch) in common with neighboring portion.

For development, the portion of the tissue containing all the panorama is developed simultaneously; by this means the intensity of all the sections will be identical.

When the film is detached from the paper, the separate sections are cut and placed on the moistened with water glass plate is respective relation to each other, which can be easily done, the tissue being quite transparent. In this stage the separate negatives will overlap each other a little. A sharp knife is now passed over the line intended for junction, and overlapping bands of the tissue removed. With ordinary care, the junction thus made will be almost imperceptible, but further operation will make it less so. For this purpose, solution of india-rubber in benzine, followed, when dry, by plain collodion with castor oil, is applied to the joined negative. This will perfectly unite all the separate sections, so that when the glass is immersed in the water, the film, bearing all the panorama, can be detached, and is, in fact, one negative.

I had occasion to form, besides others, one panorama from five sections, representing a gigantic negative thirty-two inches long, and this made by means of a seven-inch camera.

I scarcely need note here, that retouching, which is easier on the tissue than on the glass, may hide many imperfections of junction and others.

I think that I do not over-estimate the value of the power offered by this new system to the landscape photographer, especially now, when the large size of the pictures on the one hand, and the portability of the apparatus on the other, are the order of the day. By its adoption, many inconveniences of the direct large, just as well as enlarged negatives, are avoided; while some advantages are gained, not yet possessed by photographers—namely, the possibility to include any angle of view up to 360°, without sacrificing either rapidity or definition.

* Read before the Photographic Society of Great Britain.

POWERS OF THE RETINA.

THE following are the principal results of an inquiry into these points by Dr. W. Dobrowolsky (*Pflüger's Archiv*). Acuity of vision (perception of form) diminishes suddenly and greatly just outside the *fovea centralis*, and more gradually between this region and the edge of the retina. The rate of diminution varies in different meridians of the same eye, and in different eyes, even when their central acuity happens to be equal. The power of the peripheral portion of the retina to distinguish form may be greatly improved by practice; and this relative improvement is more marked in proportion as the margin of the retina is approached. The state of ocular refraction does not seem to exert any influence on peripheric acuity of vision. It may be affirmed, generally, that the lessened visual acuity of the peripheral part of the retina is chiefly due to peculiarities in the anatomical structure of the retinal elements. The sensitiveness of the retina to light is not affected by anomalies of accommodation; it sinks abruptly on the yellow spot itself, just outside the *fovea centralis*. Between this region and the extreme edge of the retina the diminution progresses, but much more slowly and gradually. The sensitiveness of the peripheral zone to luminous impressions is not improved by exercise. The sole analogy which can be made out between the visual acuity of the retina and its sensitiveness to light lies in the abrupt diminution which both undergo in the immediate neighborhood of the yellow spot. The former is much more rapidly diminished than the latter. In respect of color, the periphery of the retina divides itself into two zones which pass gradually into each other. The inner of these zones is capable of discriminating finer shades of difference in the intensity of colors; the outer one is decidedly less sensitive, and can only be excited by colored light of considerable intensity. The power of perceiving colors diminishes more than one half in immediate proximity to the yellow spot; the rate of diminution is more rapid on the outer than on the inner half of the retina. The sensitiveness of the retina to blue rays is more rapidly lessened than that for red or green light as we recede from the yellow spot. Nevertheless, as we approach the *ora serrata*, we find that the power of perceiving red rays is the first to be lost; that of perceiving green rays is the next to fail; so that at the extreme edge of the retina, only blue can still be recognized.—*Academy.*

PROTECTION OF STEAM-REDS AGAINST THE ACTION OF IRON.

STEAM-REDS got up with extract of madder or artificial alizarine are very sensitive to iron, and especially to the contact of the steel doctors of printing machines. The color, which consists mainly of nitrate of alumina, acetate of lime, thickening, and acetic acid, attacks the doctors, and appears dull and fawn-colored from a trace of dissolved iron. The steel doctors are therefore replaced with brass ones, or covered with a solution of shellac, wax, or soap. This, however, is not a protection in all cases, and brass doctors are sometimes inapplicable, on account of their softness. Wagner finds that an addition of sulphocyanide of potassium entirely prevents the color from attacking the iron, and preserves it in all its beauty. He uses ¾ oz. to 35 fluid ounces of color, and finds no change in the color on printing fifty pieces. No change was perceptible if steel was steeped for twenty-four hours in the color, whilst in the absence of the sulphocyanide the metal was corroded. Depierre confirms Wagner's communication, but he considers the sulphocyanide of potassium only effective if nitrate of alumina is present, and not in case of the acetate. The iron causing the mischief must be peroxidized if the sulphocyanide is to produce its full effect. The sulphocyanide of ammonium is inactive. Depierre recommends, however, as the cheapest preservative, to add to the alizarine red an arseniate, which converts the dissolved iron into an insoluble arseniate, and render its harmless. We cannot agree with him. Are the cases to be rendered more numerous in which traces of arsenic are detected in printed tissues, and is any support to be given to the stupid outcry about poisonous colors? On the contrary, arsenic must be entirely discarded in dyeing and printing in order to cut the ground entirely away from under these fables.—*Reimann's Färber-Zeitung.*

TYPHUS COMMUNICATED BY VACCINATION.

IN the commune of Campomarone there is an institution for young ladies under the charge of the Sisters of Charity, which contains one hundred and thirty young girls. The girls are divided into three classes: large, medium, and small, and these are separated from each other. One of the boarders was recently attacked by variola, and Dr. Parodi, the house-physician, thought proper to vaccinate the others to prevent an epidemic. He commenced with the older ones and vaccinated fifty; ten of these were successful. Three weeks later thirty-four of those who were unsuccessfully vaccinated fell sick at nearly the same time; all were attacked by typhus and three died. Their sanitary condition, before the epidemic, had been excellent, and the regimen was very good.

The virus used was humanized, and Dr. Domenica Bomba, who makes the report, does not doubt that it was the vehicle of the infection. He believes that the ten successfully vaccinated cases escaped the epidemic because the typhus virus and the vaccine mutually neutralized each other. It was impossible for one of them to make its explosion without annihilating the other.—*La Nuova Liguria* and *Le Progrès Med.*

POISONOUS RED CARPETS.

GERMAN industry has supplied commerce with carpets of a fiery red color, which owe their beautiful shades to a coloring matter which is known under the name of Vienna lake, rose lake, etc. These carpets are very poisonous, since chemical analysis has demonstrated the presence of arsenious acid; once in the proportion of 1.96 per cent, another time of 2.49 per cent.—*Il Medico di Casa.*

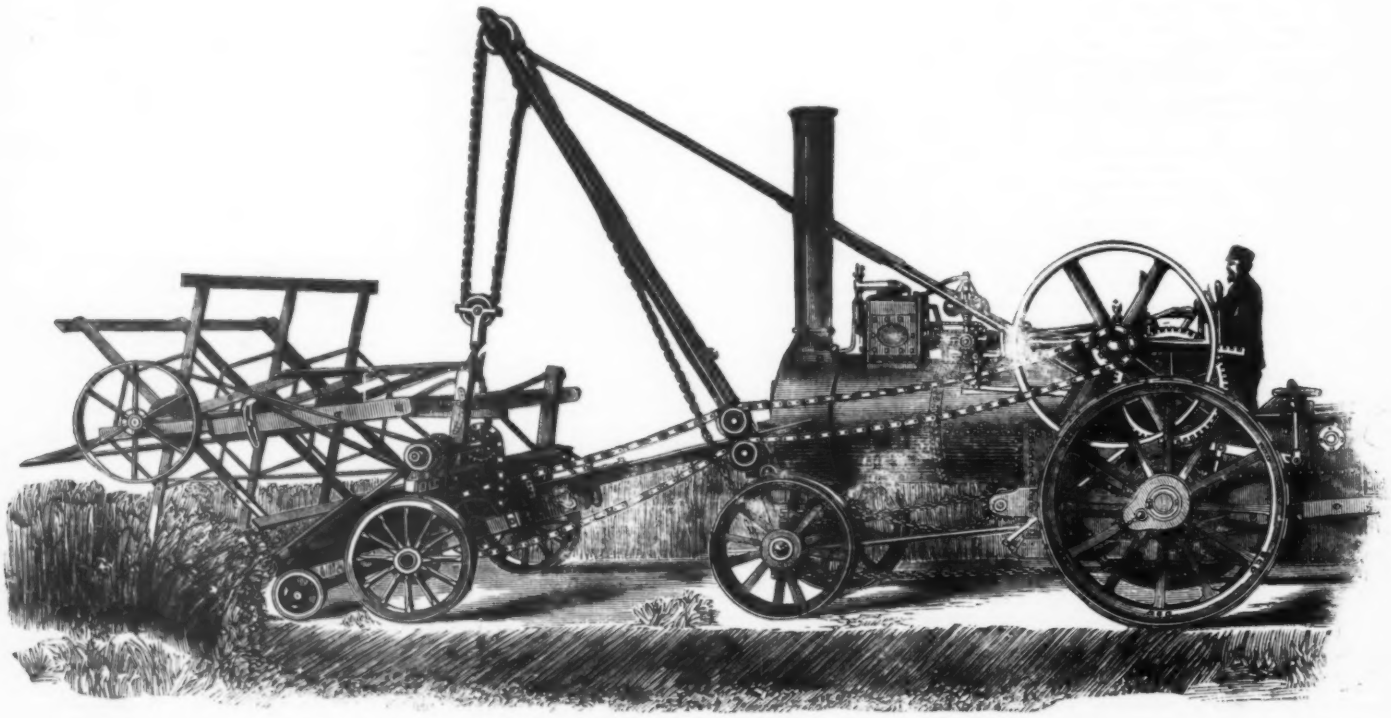
COMBINED LOCOMOTIVE AND REAPING MACHINE.

CONSTRUCTED BY MESSRS. AVELING & PORTER, ENGINEERS, ROCHESTER, ENGLAND.

THE agricultural locomotive steam engine having been successfully adapted to the work of ploughing, thrashing, and hauling, it some time ago appeared to Mr. Thomas Aveling, of the well-known firm of Aveling & Porter, of Rochester, England, that it would be advantageous if its services could be further utilized by its application to reaping and mowing, and we annex an engraving of an arrangement designed to carry out this object.

The machine is capable of clearing a space of 12 feet in width, and delivering the cut corn to either side in swathes sufficiently large that sheaves can be gathered without a rake. Motion is communicated from the engine by means of a pitch chain driven from the crank-shaft end, the liability to slip on the part of the carrying wheels of the horse machine being thus avoided, and the reciprocating motion of the knife at a proper speed being secured. The machine is connected to the engine by means of two angle-iron bars secured to the frame of the reaper. A bolt passing through the ends and through the smoke-box enables the reaper to be lifted by means of the crane clear of the uncut crop when the machine is turned at the end of the field. When thus lifted, the engine can also readily carry the reaper from one position to another.

The engine is an eight horse-power agricultural locomotive of Messrs. Aveling & Porter's ordinary type, fitted with a crane, and it can be steered and managed by one man. Like all those lately made by Messrs. Aveling & Porter, it has the bearings of the crank-shaft, counter-shaft, and driving-axle carried by the side plates of the fire-box casing, these plates being extended upward and backward for this purpose. The whole combination of engine and reaping machine, says *Engineering*, to which journal we are indebted for the engraving is well worked out, and it is one which we consider possesses great promise.

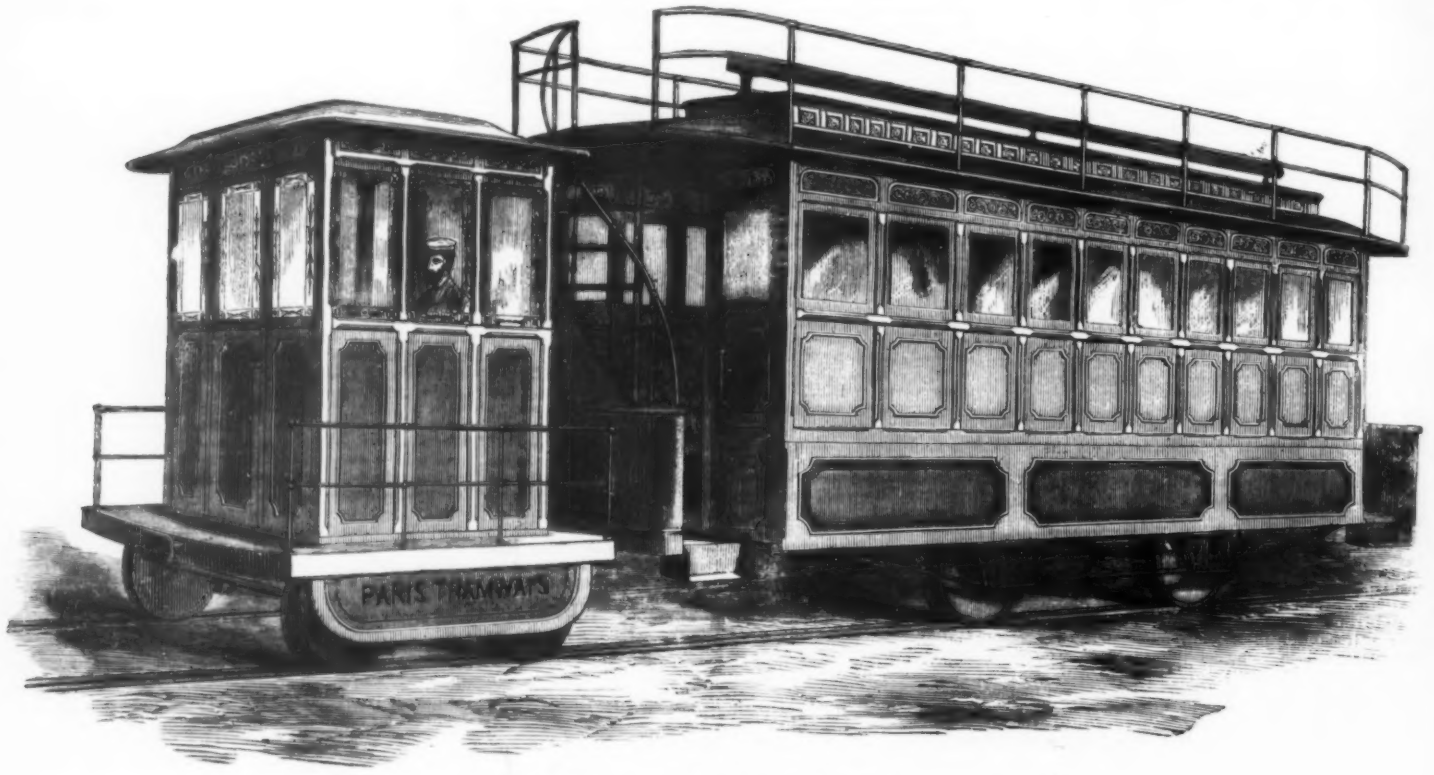


AVELING & PORTER'S FARM LOCOMOTIVE REAPING MACHINE.

NEW STEAM STREET-CAR.

OUR engraving shows the new steam street-car lately tested in operation in Paris, on the line from St. Germain-de-Prés to the Porte de Chatillon, a distance of 2¾ miles. The car, containing forty people, was drawn by the engine in sixteen minutes, or about 8½ miles per hour. On arriving at the Porte de Chatillon, the engine was reversed, and made the return journey at between 9½ and 10 miles an hour. The engine, which is a vertical locomotive, is inclosed in a frame-work exactly like a portion of an ordinary tramway car, having a small chimney. This chimney carries off the smoke, which is really almost imperceptible. The roadway had not been cleared. In that quarter of an hour the car met riding horses, and horses in all sorts of vehicles, cabs, carriages, and wagons, but caused no alarm or tremor to any. These animals certainly looked, says the observer, as if they would have liked to be relieved from drawing burdens, but that was all. There is a special advantage in the construction of this engine, which commends it to all who have any care for animal relief, in that it stops very quickly. Five feet is quite enough between brake and stand-still. And then upon the sharp curvature of the Chatillon Road, caused by the rails being laid in order to avoid a gutter, where danger was even expected by many travellers, the speed was not slackened nor was there any jar. So at the corner of the Rue de Rennes, where the road is almost an angle, the same speed and the same safety ensued; and in one place, where the laziness or obstinacy of a coachman delayed the train by blocking the line, the pull-up was all but instantaneous—much quicker than it could possibly be had horses been employed.

The part of Paris thus traversed is a populous one, and a great crowd assembled at the terminus to cheer and congratulate the promoters of the enterprise. It is believed in France that the system can be applied to ordinary roads, if they are well made and tolerably level. If so, there will follow an enormous saving to individuals in their daily expenses and in their prosecution of trade. Its cost is about a shilling an hour for coals; it is worked by a driver and stoker at say £3 3s. a week—that is to say, a total of 16s. per day against £2 10s., which is the cost of horse supply and all its attendant charges.—*The Practical Magazine.*



NEW STEAM STREET-CAR.

MARBLE CLOCK, DESIGNED BY MR. O. GRADLER, BERLIN. (From *The Workshop.*)

CARVED PANEL ORNAMENTS.—BY F. KIEFHABER, MAGDEBURG. (From *The Workshop.*)

EGYPTIAN ANTIQUITIES.

MR. R. L. N. MICHELL, in a letter from Egypt, in the *Academy*, gives some interesting particulars of the Boulak Museum and of the labors of Mariette Bey, the distinguished discoverer and scholar, who has charge of the Museum. The letter says:

Thanks to the great kindness of Mariette Bey, I am now able to mention the additions and alterations just made by him at Boulak in consequence of the important recent discoveries, to the investigation of which he has of late been devoting so much of his time. The result has been the entire re-organization of all monuments classed as historical. This arrangement, while it is of the highest interest to the general public, is of such scientific importance that the collection of Boulak (which contains the most valuable monuments that exist for the determination of the chronological history of ancient Egypt) may be said to enter upon a new epoch of its existence. The additions which call for special attention are:—

1. A case in which a collection of small objects—chiefly scarabs bearing royal cartouches—are placed in chronological order, in illustration of the entire series of dynasties.

2. A group of royal heads, sculptured in granite and other materials, which are all remarkably interesting. The one, however, which demands special attention is that of a king of the name of *Smendis* (XXI. dynasty). This is a name hitherto unknown; Mariette Bey has, therefore, not only added a new king to the records of this dynasty, but has also adorned Boulak with his royal portrait. This Smendis was, says Mariette Bey, a king who ruled at San (the Biblical Tanis) at a period when the upper country was governed by the chief priests of Amon at Thebes.

The present may be deemed a fitting occasion to mention briefly those monuments, as re-arranged at Boulak by Mariette Bey, which he considers to be of the highest historical importance. It is needless to observe that many of the objects in the museum which are of the highest value from a scientific point of view are such as to attract small notice from the public in general.

As no monuments, unfortunately, have up to the present time been discovered illustrative of the first and second dynasties, the records of the third come first in order.

Dynasty III.—The chief monuments of this period are the two statues of Meydoum (from the necropolis that encircles the "False Pyramid" so named). These represent a Prince, Rahotep, and a Princess (wife or sister) Nefer-t, who lived in the time of Snefrou, last sovereign of the third dynasty. "At no epoch," says Mariette Bey, "has Egypt produced more speaking likenesses than in the case of these statues, which reveal such perfection in art at a period prodigiously remote. . . . . Lastly," continues the catalogue, "we must allude to the importance of the statues of Meydoum from an ethnographic point of view. If the Egyptian race was of the type which is here presented, it must be admitted that it bears no resemblance whatever to the race which inhabited the North of Egypt a few years only after Snefrou. To gain an idea of the problem which we here suggest we have only to compare these statues of Meydoum with those in the museum of the fourth and fifth dynasties."

The other remarkable monuments are portions of two façades of a tomb, also at Meydoum, which was that of a family living at the same remote period, just anterior to the dynasty which reared the Gizeh Pyramids. The fragments of these façades are painted in vivid colors upon an outer coating of stucco. We see a group of geese, half life-size, in which the execution of detail and the preservation of color is striking in the extreme, when we consider that these are absolutely the oldest Egyptian monuments in the world, having attained, according to the chronological tables of Mariette Bey, the very respectable age of about 6200 years.

Dynasty IV.—The chief monument is the large statue, in diorite, of Cnephren—builder of the second Pyramid of Gizeh. The other monuments include the *débris* of various statues of Cnephren, recently added to the collection by Mariette Bey, and now placed in the garden of the museum; and two large sarcophagi, which are those of two sons of Cheops.

Dynasty XI.—The "Tablet of Antifas II." This is a royal stela, coming from a small pyramid at Thebes.

Dynasty XII.—Various statues of queens from Tanis.

A colossal statue, in black granite, representing a king of this dynasty, and one of the finest specimens of Egyptian art. The name of Ramses II. has been subsequently inscribed upon the statue.

Numerous royal stelæ, which record events in the lifetimes of kings and of private individuals of the XII. dynasty. These records possess great historic value, inasmuch as such biographies furnish dates, or at any rate facts, which aid in fixing the chronology of the period. For instance, in some cases, it is recorded of such or such an individual that some event took place in the lifetime of a certain king; while another event, such as his death, took place in that of a successor. These tablets are not yet described in the catalogue.

Dynasty XIII.—Various records of kings, chiefly from Thebes and Abydos. One royal stela, bearing the name of a king Nefer-hotep of Abydos, is of an interesting character. It records that a visit was paid by Nefer-hotep to the library of the Temple of Osiris at Abydos, on which occasion the MSS. were found to be in a sorry condition of neglect. Orders were, therefore, given by the king to replace the MSS. by fresh copies, and to place the library under repair.

Dynasties XV., XVI., XVII.—Period of the Hyksos, during which the Shepherd Kings ruled in Lower Egypt, while the legitimate kings held dominion in the upper country.

It is at this point that the discoveries of Mariette Bey have been of such extreme importance in bringing to light various names and events that illustrate this portion of the history of the now divided kingdom. The monuments of this epoch with which Mariette Bey has enriched the Boulak Museum invite special attention, since they speak of a period respecting which the museums of Europe are silent. The chief of them are as follows:—1. Sphynxes, and especially statues of two kings, who stand upon the same pedestal, and hold in their hands water-fowls and various fish, together with the flowers of the plant called "bashnin." These are described by Mariette Bey as undoubtedly representing two of the Shepherd Kings. Another name, that of Pesoussennès, had been added, as is so often the case, at a subsequent period. As regards the type of physiognomy, "the features are hard and unprepossessing, and bear a strong resemblance to the lion-maned Sphinx of the same epoch. The upper lips are shaven, but the cheeks and chin are covered with an abundant growth of wavy hair. The heads are covered with huge wigs, arranged in coarse tresses." 2. From Thebes, various objects illustrating the domination of the kings of Upper Egypt who were contemporary with the Hyksos ruling in Lower Egypt. Among them is a long wooden sword, bearing the name of one of these kings.

Dynasty XVIII.—Great period of Renaissance—a period richly illustrated in all the collections of Europe; especially, as regards important historical monuments, at Turin. What is noticeable at Boulak is the collection of gold ornaments and jewels, which always attract so much attention from visitors. They were the property of a queen who lived at the beginning of the eighteenth dynasty.

Dynasty XIX.—The celebrated "Sakkara Tablet," engraved on both faces, of a priest of Memphis, named Tounar-i, who died in the reign of Ramses II. It is the list of fifty-eight kings inscribed upon the outer sepulchral chamber of this priest that is so valuable in confirming, as far as it goes, the lists of Manetho.

Dynasties XXII.-XXVI.—This was a period enveloped in complete obscurity until the publication of the results of the excavations conducted by Mariette Bey at Gebel Barkal (the Biblical Noph: the Napata of Strabo) threw entirely new light upon what was before a region of mere conjecture.

The chief monuments consist of five stelæ, which furnish information concerning the flourishing Ethiopian Empire formed in the "Soudan"; which, having been annexed to Egypt in the XVIII. dynasty, adopted the civilization of the conquering race. Then, during a period beginning with the XXII. or XXIII. dynasty, it became the rival of its former conqueror, and subsequently brought under subjection all Egypt to the shores of the Mediterranean; so that the symbols of a double royalty were combined in the persons of its kings. The five tablets appear to furnish rough outlines for a historical sketch that would portray the rise, the grandeur and supremacy, and finally the decadence and re-isolation of this great Ethiopian Empire.

THE LOAN COLLECTION OF SCIENTIFIC APPARATUS, LONDON.

NATURAL MAGNETS.

Of the natural magnets we may notice a large one—the largest at present known—from the Teyler Museum, Haarlem; the weight of this magnet with its armature is 3 cwt., and it is capable of supporting a load of over 2 cwt; also a Siberian loadstone used by Faraday, and from which he first obtained the induction spark. Large permanent magnetic batteries are contributed by Dr. Guthrie and the Teyler Museum.

MAGNETIC NEEDLES.

There is a number of modern and historical dip-circles one from the Naval Museum at Greenwich, with 9 inch needle moving on friction wheels, said to have been used by Captain Cooke in his voyages round the world; others similar, but with the needles rolling on agate plates; a dip-circle used by Sir James Ross, that at present in use at the Kew Observatory, and another contributed by Dr. Lloyd, in which needles of various lengths may be employed. Of the ordinary compasses we need say little; here are seen the various forms now in use in H. M.'s ships, standard compasses with four needles, steering compasses with two needles, liquid compasses—the compass box being filled with a mixture of water and alcohol-and-water—compasses for boats, sledges, etc. There is another form of compass-card, however, which should be noticed—namely, that recently introduced by Sir William Thomson, of which four examples are exhibited. In the smallest of the cards there are two needles, each about 1¼ in. long, placed parallel to each other and on either side of the centre. The card is extremely light, is supported by a sapphire cap on a steel point, the cap being mounted in aluminium, and weighs with magnets and all only 44 grains, that is, only ⅓ the weight of the Admiralty compass of the same dimensions and period of oscillation. In the larger cards there are as many as eight needles, placed symmetrically with regard to the centre. The object of this form of card is to obviate the occurrence of a certain deviation of the compass usually introduced by the masses of soft iron which are employed for correcting the quadrantal error. In connection with this subject we may notice a model lent by the German Hydrographical Department for illustrating the method of correcting the deviation of the compass in iron ships.

ELECTRICITY.

The old electrical machines are very interesting. Among them will be seen Priestley's electrical machine, consisting of a glass globe which can be rotated on a fixed rubber, negative electricity being obtained from the rubber. Nairne's original globe and cylinder machines from King's College; a machine made by Singer and used by Ronalds in his early experiments in connection with the electric telegraph, described in 1823; and Armstrong's hydro-electric machine—an old iron boiler standing on glass legs.

THE AURORA.

Prof. Lemström's polar light apparatus should be noticed, intended for showing that the Aurora Borealis is an electric current flowing from the higher regions of the atmosphere to the earth.

INDUCTION.

From the Royal Institution we have the original apparatus with which Faraday obtained the magneto-electric spark in 1831. It consists of a ring of soft iron, six inches in diameter, with two coils of insulated copper wire wound round it, each coil occupying nearly half the ring. When the ring was converted into an electro-magnet by passing a current through one of the coils, an induced spark was seen at the carbon terminals of the other. The Royal Institution contributes also Faraday's rotating rectangle for illustrating the inductive action of the earth, and other apparatus used by Faraday.

ASTRONOMY.

The quadrant made by Tycho Brahé is a beautiful specimen of his workmanship, and, notwithstanding its age, in excellent preservation. It is adapted to the measurement of azimuths as well as of altitudes, which was absolutely necessary for the determination of the positions of the stars before the invention of the clock. Since the middle of the last century, however, when Graham introduced his great improvements in the astronomical clock, quadrants have been fixed in the meridian, and used only for measuring altitudes, the other co-ordinate of a star's place being given by the time of meridian passage. The principle of Tycho's quadrant has been perpetuated in a large class of modern instruments known as alt-azimuths, or theodolites, though in the case of many of them the resemblance appears at first sight very slight indeed.

TELESCOPES.

Among the telescopes, much interest naturally attaches to that of Galileo, which is contributed by the Reale Instituto, of Florence, together with his microscope and air-thermometer; we find also several object-glasses and telescopes by Huyghens, remarkable chiefly for their unwieldy length, which was adopted for the sake of reducing the chromatic aberration as much as possible, until Dollond, by his discovery of the achromatic object-glass, reduced the refracting telescope to reasonable proportions. In contrast with these is the original reflector made by Sir Isaac Newton and contributed by the Royal Society, its total length being only a few inches, while its aperture is greater than some of Huyghens' telescopes. Other interesting contributions are a polishing machine by Sir W. Herschel, and several telescopes made by his own hands, and an experimental compound speculum made by Lord Rosse before he succeeded in constructing his three-feet and six-feet reflectors. There are also models of the mountings of large telescopes, including Lord Rosse's six-feet, an equatorial mounting for his three-feet mirror, one of the Melbourne four-feet reflectors, and one of the new Vienna refractor, now in course of construction by Grubb.—*Academy*.

FRENCH ACADEMY OF SCIENCES.

JULY.

On a Vegetable Rock. By MM. Bureau and Poisson.—The soil of a cavern, recently visited by M. de l'Isle in Reunion Island, is formed for a depth of over three feet of a yellow-ochreish substance, soft to the touch, tasteless, inodorous, easily divisible into very light fragments, which leave upon the fingers a yellow powder, or which may readily be reduced to pulverulent state by pressure or friction. When the material is dry it burns with a yellow flame without smoke or odor. If damp, it smoulders like starch, with much smoke, and the smell of burnt herbs. This interesting substance is entirely composed of small bodies, which are nothing but spores or pollen grains, very analogous to those of a sub-order of polypodiæ peculiar to the island. The species is abundant, and possesses a very large leaf. The cohesion of the spores, as well as the break in each, through which the contents have escaped, renders it probable that the accumulation is due to both water and wind.

On the Determination of Fuchsine and Arsenic in Wines Artificially Colored by Fuchsine. By M. C. Husson.—If fuchsine is employed in a chemically pure state, no great inconvenience attends its use. But the present product employed is arsenical, and to this fact may be ascribed the various accidents which have been reported. The author gives the following quick and certain method for its determination: After having decomposed the suspected material by ordinary processes, so as to transform the arsenic into arsenite or arseniate of potash, the residue is dissolved in a small quantity of distilled water. The solution is divided into two portions, one for qualitative analysis, the other for the determination of the arsenic. The last portion is again subdivided as before, one part serving for an approximate determination by the preceding method, and with the other a more exact determination is made by the following means: To the disengagement tube of the Marsh apparatus a larger tube is adapted, containing asbestos and filtering paper in order to dry the gas. From this tube extends another, curved to pass to the bottom of a long test tube, the opening of which is closed by a rubber stopper, in which two holes are made, one for the curved tube, the other leading to a similar test tube. Five or six test tubes are thus connected. In the first is placed .15 grain of iodine; in the next two, .06 grain; in the fourth, .015 grain; the fifth, .006 grain; and in the sixth, .001 grain, the iodine in each case being dissolved in 1.2 cubic inches of benzine. If the current is well moderated, it may be deemed certain that all the arseniuretted hydrogen is decomposed by the iodine and that the number of test tubes discolored indicates the exact quantity introduced into the apparatus.

On a New Compensating Pendulum. By Professor J. Lawrence Smith.—The author has recently successfully employed the combination of sulphur and (rubber known as vulcanized rubber, vulcanite or ebonite) on account of its dilatability, in the construction of a new compensating pendulum. It is known that the dilatation of this body approximates that of mercury for temperatures comprised between 32° and 168° Fahr. The rod of the pendulum is formed of a round steel verge, having a screw at its lower end. A cylindrical piece of vulcanite surrounds this extremity, and is maintained by the screw. The bob of the pendulum is formed by a piece of copper pierced with a cavity to hold the vulcanite cylinder, which it rises above, and on which it is sustained by means of a stop. All dilatation of the vulcanite, therefore, lifts the copper mass, and so compensates for the extension of the steel rod. The following dimensions have been adopted for the seconds pendulum of an astronomical clock: Diameter of the steel verge, .234 inch; diameter of the vulcanite, .975 inch; length of same, 6.4 inches; diameter of copper weight, 2.4 inches; length of same, 6.08. This pendulum has worked satisfactorily for four months.

On the Production of Prismatic and Octahedric Sulphur Crystals. By M. Gernez.—Sulphur assumes two incompatible crystalline forms: the right octahedron with rectangular base, generally prepared by the spontaneous evaporation of solutions in sulphide of carbon, and the oolige symmetrical prism, obtained by fusion. The two kinds of crystals may be reciprocally transformed at suitable temperature. Thus each prism maintained at ordinary temperature divides, with disengagement of heat and without changing its exterior form, into a multitude of small octahedric crystals; and similarly octahedra sufficiently heated experience an analogous dentrification, and become transformed into prisms. The results of the author's investigation into this subject show that the temperature of 243.3° Fahr., which is the point of fusion of prismatic sulphur, is confounded with the point of solidification of octahedral sulphur melted below 266°.

On the Action of the Hydracids on Selenious Acid. By M. A. Ditte.—Hydroselenic acid, in dry state, acts at a slightly elevated temperature in selenious acid. Water and a black deposit of pulverulent selenium is produced.

On the Iodine Test for Starch. By M. Puchot.—A solution of iodine, decolorized by albumen, no longer colors starch blue. This may be shown by triturating starch in a mortar with a little albumen. Each drop of iodine subsequently added produces a local blue spot, which however disappears as the drop extending over the surface comes in contact with greater quantities of albumen.

On Rhodeine: a New Reaction of Aniline. By M. Jacquemin.—When aniline, or its salts, are in a state of considerable dilution (.01 in 200 parts of water) the hypochlorites produce only a light brown shade without definite character, and when .15 grain of aniline is dissolved in 30 cubic inches of water, the same chemical agents, added in quantities of 10 or 15 drops, produce no visible effect. The water keeps its transparency. If, however, there be added a few drops of a very extended solution of ammonic sulphur (1 drop to 1.8 cubic inch of water), a magnificent rose color is developed, more or less dark, according to the degree of dilution of the aniline. The author applies the name "rhodeine" to the new derivative.

On New Nickel Deposits in Spain. By M. Meissonnier.—There exists in the province of Malaga, Spain, a large deposit of nickel, of which the exploitation has lately been begun. Analysis shows for 100 parts of ore: nickel, 8.96; cobalt, none.

On the Cutaneous Respiration of Frogs. By M. Tubini.—Seventy-four experiments made on frogs deprived of lungs, in darkness and under the influence of light, demonstrate a difference of carbonic acid of 100 to 134. The action of light appears therefore to augment the disengagement of carbonic acid.

OZOKERIT.

In a recent number of the *Zeitschrift* of the German Society of Engineers, Dr. List has a long memoir on this substance, which has of late years come so largely into use. The following details are from his paper:

Of the places where ozokerit is found only those in Galicia have industrial importance, especially those in Boryslau, near Drohobycz, in the Moldau, and on the Caspian Sea. In Boryslau alone 325,000 cwt. were produced in 1870, and the value of the Galician production in the same year appears to have been about 6.8 million marks. The normal Galician pitch coal consists of a viscous, plastic, fatty-feeling, brownish-yellow mass, without mixture of liquid substances. In mixture with more or less petroleum it forms the viscous so-called kindybal, or a light liquid tar. In the same pit, however, there is generally found raw oil or naphtha, tar, kindybal, and ozokerit; these pass into each other, so that they can not always be sharply separated. From the Kindybal the ozokerit is obtained by remelting and by volatilization of the liquid parts. The prepared ozokerit of Boryslau is dark brown, has a slight empyreumatic odor is, in fracture, very like raw beeswax, readily takes impressions from the finger nails, is easily cut, and without sticking to the knife, and can be kneaded between the fingers. The melting point is somewhere about 63° C., the specific gravity somewhat less than that of water. In ether it is partly soluble; the part dissolved is separated out in the form of microscopic crystal scales, which, after drying, form a somewhat sticky powder. In boiling alcohol of 95 per cent the same constituent is but little soluble; a very frequently repeated boiling would be necessary to fully extract it; on cooling of the solution it separates out in crystalline flakes. Other specimens which List examined presented some differences, of course, especially in hardness and fusibility.

Of special practical importance is the behavior of ozokerit in distillation. The distillate of all, even the hardest, kinds of ozokerit consists of solid and liquid parts, the former naturally predominating. The ozokerit, namely, undergoes decomposition in distillation, and there arises a paraffin-like mass and a liquid product—in short, it is decomposed into matters of lower melting point.

The employment of ozokerit for lighting purposes dates pretty far back. The inhabitants of Boryslau have long prepared candles from the fused masses without further purification, but these, from their plain appearance, never came widely into use. It is some twelve years ago that ozokerit began to be subjected to distillation in order to the obtaining of purer products. The modes of treatment of the ozokerit for paraffin adopted by Rossmässler in his works on the island of Swätor Ostrow, in the Caspian Sea, near the peninsula Apscheron, and by Field, in Lambeth, agree in that the raw material is handled like the product obtained by dry distillation of brown coal and bituminous schist, and so the use of ozokerit for the manufacture of paraffin offers the great advantage over that of brown coal, that with it the whole first part, the smouldering process, is dispensed with. The works which prepare ozokerit are thus to be placed by the side of those paraffin manufactories which operate only with purchased brown coal tar. But the work is also simpler—for example, a purification with soda solution, such as is necessary in first rectification of the raw oil obtained from tar, on account of the contained creosote, is superfluous. But the ozokerit is especially distinguished for its greater yield of ready good products. These, according to Albrecht, amount, in brown coal tar of average composition, from 60 to 68 per cent, but in ozokerit to 82 per cent, and these are obtained from

	Brown coal tar.	Ozokerit.
Paraffin	15 to 17 p.c. 1.0	36 p.c. 1.0
Lighting oil	28 to 35 p.c. 1.8	25 p.c. 0.7
Greasing oil	10 to 15 p.c. 0.6	21 p.c. 0.6

From the percentage proportion are reckoned the ratios of the different products to each other. The paraffin forms, among those of brown coal-tar, 23.8 to 24.3; among those of ozokerit, 43.9 per cent. These numbers sufficiently explain how desirable a substance ozokerit has become for the paraffin industry.

The candles manufactured by Field from ozokerit are, in appearance, very like those from bleached wax; in appearance of cut section they also agree. The melting point List found = 60° C., agreeing with Letheby, who gives it as 59.5° C. The Field ozokerit candles, in this respect, rank equally with the wax candles and the so-called stearine candles, prepared from palm oil, as the following comparative table shows:

	Melts at
Carnauba wax	85° C.
White ozokerit of J. F. Otto	83° to 74°
Chinese wax	77°
Pure stearic acid	69°
Pure palmitic acid	62°
Ceresin from Stockerau	62°
Beeswax, bleached	61°
Ozokerit candles of Field	60°
Paraffin	55° to 45°
Spermaceti	45°
Japanese wax	42°
Tallow	37°

Letheby asserts that while some kinds of paraffin candles do not resist a temperature of 30°, and most kinds become soft and bend at 36°, the ozokerit candles at 42° are still firm and hard (a temperature which is higher than that of an ordinary room). In luminous power the ozokerit candles excel all others; thus to give the same quantity of light as 1000 gr. of the best spermaceti candles, there are required

	Gr.
Ozokeri of Field	751
Paraffin	798 to 891
Spermaceti	1,000
Wax	1,150
Stearic acid	1,200
Tallow	1,570

Moreover, in favor of the ozokerit candles are the facts that they are quite free from smell, and are not greasy to the feel.

Notwithstanding all these advantages of the product obtained from natural ozokerit, it is to be noted as a drawback, when ozokerit is used as a raw material for paraffin, that it is subjected to a destructive distillation. While the raw ozokerit requires, for its liquefaction, a temperature of about 60°, the entire distillate is, at ordinary temperature, only of butter consistency, and it liquefies completely at about 30°. Thus to the object of decoloring the material is sacrificed the highly-prized property of lighting material, difficult fusibility. The ozokerit, as already stated, can not be distilled without decomposition, but is separated on continuous action of heat into a liquid and a solid easily fusible product. But still another valuable property of ozokerit does not pass over into the solid mass obtained from it by distillation—namely, the elasticity, which makes it so similar to wax. The Field candle material allows of being kneaded between the fingers only so long as it is still warm after passage out of the liquid state; at ordinary temperature it can be crushed like stearic acid; and just as little as this, can two pieces of it be welded together with the aid of heat, whereas this can as easily be done with the natural ozokerit as with beeswax. The Field ozokerit candles, therefore, by no means consist of ozokerit purified in the course of manufacture, but owe their name merely to the raw material, and bear it with no greater right than the "stearine candles" do theirs.

It is, therefore, to be regarded as a decided advance, when, in the working of ozokerit, deep reaching treatment by distillation is departed from, and the aim limited to a removal of the color. This plan has been adopted by J. B. Otto, in Frankfort-on-the-Oder, and how well he has reached his object was shown at the Vienna Exhibition in 1875. He has succeeded in producing perfectly white ozokerit of 83° melting point, and so hard that it can scarcely be scratched with crystallized gypsum or the finger-nail. With apparently crystalline structure, and splintering fracture, it yet has retained the property of being kneadable between the fingers like beeswax; the crystalline character is herewith more and more lost, and after some time two separate pieces can be united together by pressure like wax, a behavior which is wanting in Field's ozokerit candles. Further, a kneaded piece of this purified ozokerit, after pressure to a smooth wooden surface, sticks as firmly as wax (a thing which neither paraffin nor stearin does, and even the unkneaded pure ozokerit only in small degree). The purified ozokerit is superior in properties to all other candle materials; in difficult fusibility it is scarcely exceeded by the Brazilian carnauba wax, and it can, like this, be used to make easily-liquid material—for example, white paraffin, available for candle manufacture.

This success has been attained by M. Otto (as Dr. List tells us) by treating preferentially the hardest kinds of raw ozokerit, of 70° and higher melting point. While the Vienna manufactories (for the sake of lighter work chiefly) buy materials of only 59° to 60° for bleaching, he uses no violently acting chemicals, but proceeds on the principle that gentler means and longer time save the powerful chemicals and give better results, without disagreeable bye-products at the cost of the raw material. The melting point may be raised 5° (and so to 89°) without the yield being diminished, but the mass becomes undeniably crystalline, and like transparent paraffin.

The "first Austrian Ceresin Manufactory" of H. Ujhely and Co., in Stockerau, by Vienna, has for its object the supply of a substitute for beeswax. The question is not that of the use of a material for candles, whose sole purpose is to serve for illumination; for the beeswax is neither in regard to fusibility nor to light intensity preferable to the cheaper stearic acid by which it has therefore been quite driven out from this field; but besides the wax-sticks, the candles for church use in Catholic countries, and the like, wax is always being employed for various purposes, in the making of fancy articles and in industry in so great a quantity, that the present bee cultivation no longer suffices to meet the demand for wax. As a consequence of this, the admixture of other substances with wax—for example, paraffin, turpentine, etc.—has been greatly extended. In opposition to this adulterated wax, ceresin is offered as a true and pure substitute. The way in which it is prepared is still a secret, and probably the statement of the Official (Exhibition) Report that "we have here a mixture of the ordinary beeswax, with more or less soft paraffin," is purposely not confirmed by the initiated. For since the three manufactories in Austria—H. Ujhely, in Stockerau; J. Wagemann, in Vienna, and one in Galicia—make ceresin from ozokerit, and in communications from one of them the name "mineral wax" is used as synonymous with ceresin; since, further, the bleached ozokerit obtained by J. F. Otto from earthwax, without any addition, and through simple purification, has retained the wax-like character of the natural material, while the material purified by Field by distillation, similarly to paraffin, shows also the behavior of paraffin up to its melting point, we may infer that the ceresin is prepared from the earthwax by simple purification and bleaching, with omission of distillation.

That all the ceresin works have plenty to do—those at Stockerau manufactured, even in 1873, 12,000 cwt.—will surprise no one who has visited the Vienna Exhibition. The problem of preparing from ozokerit all the products for which hitherto beeswax has been used, is fully solved.

The illuminating value of the kinds of candle most like wax Dr. List found to be quite as high as that of Field's ozokerit—namely, 1½ times that of wax.

For all technical uses ceresin has fully justified itself as a substitute for wax.

AIR AND AIRS.

UNDER this title the Right Hon. Lyon Playfair, C.B., M.P., F.R.S., lately delivered a lecture in the Conference room of the South Kensington Museum, London. Lord Aberdare occupied the chair, and introduced the lecturer and his subject to the numerous and closely interested audience.

Air, said Dr. Lyon Playfair, was the most familiar of substances, the first with which an infant becomes acquainted on entrance into the world, and in death the last to be given up; yet, strange to say, its nature and constitution had only become partially understood within the past century, and even now scientific knowledge could only be regarded as on the threshold of the subject. He proposed in his address to give a sketch of the progress of this branch of natural science, and Prof. Guthrie, who formerly assisted him when he occupied the Chair of Chemistry at Edinburgh, and had now succeeded him therein, had consented to illustrate his remarks by showing one or two simple experiments, of a class well-known to every schoolboy, but necessary to show the stages of development of knowledge on the subject. In the year 640 B.C., Thales, a philosopher of Miletus, travelled into Egypt, and having observed the manner in which the land was fertilized by the overflowing of the Nile, promulgated the theory that every thing was made of water, and that all life resided in it. Thales had no aids to forming a correct theory other than his untutored senses, and as far as they led him they appeared to prove the correctness of his views. In 548 B.C. Aleximenas said Thales was wrong, and that every thing was composed of air, and that it was the essence of life. His reasonings appear to modern ears utterly preposterous, but they were the first dawnings of philosophy. Five centuries before the Christian era, Diogenes of Appollonia thought over the same subject, more as a psychologist than as a natural philosopher; he considered air the *anima mundi* of the world, and that it was a spirit, usually benevolent, but liable to fits of temper, and hence storms, mists, fogs. These philosophers were of a disputatious school, and did not endeavor to test their ideas by experiments; but in 384 B.C. Aristotle, who examined things as they were somewhat more closely, divided all substances into what he named four elements—earth, air, fire, and water, and this nomenclature continued till little more than a century since. Little further was known about air till A.D. 1100, when a Saracen, named Olhausen, found that it had weight, and that, instead of extending through all space, as previously supposed, it ceased to exist beyond a certain distance from the earth. He fixed this limit at 58 miles—a good guess, as modern observers had ascertained it to reach a height of about 45¼ miles from the earth. In 1630 Galileo investigated the action of the common pump. Aristotle had said that water rose on drawing off the air because nature abhorred a vacuum. Galileo found that water would only rise in a tube 32 ft. or 33 ft.; did nature then permit of the vacuum? He soon saw that the water rose because of the weight of the air, and that the limit of a pump's action was fixed by the weight of water to be raised. After his time Torricelli applied this principle to mercury, and, as he anticipated, it would only rise about thirty inches in a pump, as it was about thirteen times heavier than water. Thus the first barometers were made, and the foundation laid of modern discoveries as to the subject. (Prof. Guthrie here showed experiments with the Torricelli tubes, and also proved that air has weight by pumping it from a small vessel attached to a delicate balance, when it rose.) It was found that air weighed about 15 lbs. per square inch, and that it varied from day to day with the weather. The next great discoverer was Otto Von Guericke, of Magdeburg, who invented the air-pump. His work on the subject of air containing an account in Latin of his discoveries, was still extant, and the lecturer had one of the two copies now preserved in this country. Guericke had several failures in his attempts to pump out air, but at length made what were still known as the Magdeburg hemispheres, two hollow semi globes, which could be tightly fitted together, and from which the air could be withdrawn. The original hemispheres were displayed upon the table, with which in 1654, Guericke exhibited to the Emperor, at the Diet of Ratisbon, his noted experiment of harnessing eight horses to each of the exhausted hemispheres, when they were unable to draw the two parts asunder. Guericke had a water barometer attached to his house, with the figure of a man floating on the water, and this popularized the instrument. Boyle, the next investigator of the air, was the first to endeavor to ascertain its chemical constituents. He got so far as to prove that there were "fictitious airs," but never sufficiently distinguished them from common air. Soon after this, Hales separated a number of what were now known to be constituent gases of air; he, however, regarded them as so many impurities, to be got rid of as much as possible. The lecturer said he spoke with peculiar interest of Prof. Black, who was distinguished for his researches into this subject, as he was the third before him in the Chair of Chemistry at Edinburgh. Black was the first to use the plural of the word air, and to use a balance for weighing air. Before his time it had been supposed that the difference between mild lime, or chalk, and caustic lime was that the principle then called phlogiston was imparted to the latter by the action of fire. Black argued that if so, quicklime ought to be heavier, not lighter, than chalk; and after some study and experiments he proved that its lightness was due to the withdrawal of carbonic acid from it, either by the action of heat, or of a stronger acid, and that quicklime recovered this from the atmosphere if exposed to its influence. He also showed that this acid was evolved by decaying substances, and passed into the air at every breath of men and animals. He also made important discoveries as to latent heat. All Black's discoveries were made when he was about twenty-four years old, and it was to be regretted, that though he lived to be eighty, he made no further discoveries. Dr. Playfair remarked that he found the balance with which Black made his discoveries in air in a lumber-room at Edinburgh, and immediately forwarded it to a museum for preservation; at present it is in the Loan Collection. Cavendish soon afterwards discovered hydrogen, the source of light and heat, and observed that it entered into the composition of water. In 1772 Rutherford discovered the great diluent of air, nitrogen, by placing mice, one at a time, in a receiver, and as they died, washing away the carbonic acid produced with lime-water and putting in a fresh mouse, till at length the little animals died directly they were introduced. Two years subsequently Priestley discovered oxygen, and observed its wonderful power of supporting light. He was persecuted and driven from England, and went to Paris, where he showed Lavoisier how to make oxygen, and thence to America, where he died. Lavoisier never admitted that this discovery was imparted to him by Priestley, although latterly he confessed that he did not make it. Lavoisier carried forward the study of air, having a power of generalizing the observations of others, and invented the calliometer. In the height of his investigations he was guillotined during the Revolution. A solemn procession was formed at a later date, and Madame Lavoisier publicly burnt an effigy of the old element phlogiston, and a requiem was sung to its memory, as a token that the old chemistry had passed away, and a new one was inaugurated. That system was now in its turn becoming antiquated and out of date Till within the last few years air was supposed to be composed of the elements laid down by Lavoisier's chemistry—oxygen, nitrogen, and carbonic acid, but Liebig showed that there was a small portion of ammonia in the air, which is washed down in rain; ozone, an active form in oxygen, had also been discovered, and certain minute organisms had also been found in the air. Fresh observations were ever being made, which tended to show how little was yet known about the air. In conclusion, Dr. Playfair explained how the air that is vitiated by the carbonic acid liberated by breathing of men and animals, and the smoke of many furnaces and fires in these regions, is conveyed by the action of trade-winds to the tropics, where the acid forms the food of a luxuriant vegetation. The air, by circulating, was thus constantly being purified, and by the beneficent action of the law that plants should subsist, not only on decaying substances, but upon the gases evolved by animal waste, the balance of nature was preserved.

HOW TO BUILD CHEAP BOATS.

By PADDLEFAST.

NO. V.—THE SIXTEEN-DOLLAR FAMILY BOAT—LENGTH, SIXTEEN FEET.

THIS boat is designed chiefly for family and social use, and is consequently planned with more regard to safety and room than speed. It will carry a dozen or more persons, and is fitted for two or four oars. Draught, with moderate load, about 8 inches. A simple sail, easily removable, may be carried, in which case the depth of keel is increased 2 inches, for a centre-board would be too much in the way. Expense of materials, without sail, is about $16. Cost of oars, anchor, and materials for sail and accessories, is not over $12 additional.

We subjoin details of construction, and remind the reader that useful additional hints will be found in our previous articles.

CONSTRUCTION.

The construction of this boat is almost precisely similar to the preceding, and chiefly departs from it in an increased number of frames and thwarts.

A working drawing is made like Fig. 36, but in this case there are 5 horizontal dotted lines (excluding the horizontal lines running to the tops of the ribs), which are 4 inches apart. The line P is as before 1 inch from line N. The necessary tables are given below as heretofore.

Table 1.

	I.	II.	III.	IV.
	Inches.	Inches.	Inches.	Inches.
Rib ⊕	16.80	22.04	23.64	23.92
" A	16.52	21.84	23.52	23.80
" B	15.56	20.80	22.88	23.60
" C	13.80	19.56	21.68	22.84
" D	11.72	16.96	19.60	21.08
" E	9.16	13.96	16.68	18.40
" F	6.28	10.44	13.04	14.84
" G	3.64	6.72	9.00	10.60
" H	1.08	2.88	4.36	5.40
" 1	15.76	21.40	23.28	23.64
" 2	13.72	20.20	22.60	23.20
" 3	10.72	18.04	21.40	22.36
" 4	7.40	14.68	19.32	21.12
" 5	3.60	10.20	16.04	18.92
" 6	.....	4.72	10.56	15.84
Stern	.....	.....	2.84	9.96

Assuming diagram E to represent cross-section of keel at frame G,

a is	.34 in.
b is	1.00 "

Assuming diagram B to represent cross-section of keel at frame D,

a is	.1 in.
b is	1.0 "

Diagram L.

a is	.23 in.
b is	.75 "

Assuming diagram 3 to represent cross-section at frame 6,

a is	.33 in.
b is	1.00 "

The width of the bevelled surface is invariably .5 inch.

The bow and stern deadwoods are curved (Fig. 60) to save weight.

The curve of the stem F, Fig. 36, should not be made so great as to make too cross a grain at the lower end.

Frame 6 is	10.40 in.	from	stern.
" 5 "	10.80 "	"	frame 6
" 4 "	11.20 "	"	" 5
" 3 "	11.60 "	"	" 4
" 2 "	12.40 "	"	" 3
" 1 "	12.80 "	"	" 2
" ⊕ "	13.20 "	"	" 1
" A "	13.60 "	"	" ⊕
" B "	13.60 "	"	" A
" C "	13.20 "	"	" B
" D "	12.80 "	"	" C
" E "	12.40 "	"	" D
" F "	11.60 "	"	" E
" G "	11.20 "	"	" F
" H "	10.80 "	"	" G

Dimensions of Ribs.

	Length.	Width of lower end.	Width of upper end.	Thickness.
	Inches.	Inch.	Inch.	Inch.
⊕	37	.7	.5	.5
A	37	.7	.5	.5
B	37	.7	.5	.5
C	35	.7	.55	.5
D	33	.7	.57	.5
E	33	.7	.65	.5
F	31	.7	.69	.5
G	27	.7	.77	.5
H	25	.7	.82	.5
1	37	.7	.5	.5
2	37	.7	.54	.5
3	35	.7	.55	.5
4	33	.7	.58	.5
5	31	.7	.61	.5
6	27	.7	.63	.5

Forward edge of thwart A, 57 inches from extreme bow.

Forward edge of thwart B, 40 inches from forward edge of thwart A.

Forward edge of thwart C, 40 inches from forward edge of thwart B.

Width of thwarts, 9 inches; thickness, .75 inch.

The bow-seat F is about 30 inches long. The stern-seat, similar to Fig. 53, is 13 inches long. The width of the stern sheets is about 10 inches.

Rowlock, shown by Fig. 59, inserted in the gunwale. They may be of galvanized iron, brass, or plated ware, as desired. The space across the jaw of each rowlock is nearly 3 inches. The middle point of each rowlock is 11½ inches abaft the after edge of the accompanying thwart.

Oars, technically called, are those used singly, one for each rower, and sculls are employed in pairs, one pair for each oarsman.

The boat is most conveniently propelled by two oars, one rower sitting on each of the thwarts A and B, and when there is but one oarsman, he may sit on either thwart, using sculls.

Oars are usually longer than sculls, when made for the same boat, but a pair of oars 9 feet long, for this boat, may be used as either sculls or oars.

The rudder is similar to that in Fig. 23, SUPPLEMENT 29, except that the wooden braces W W are replaced by iron ones. The rudder is cedar; the tiller oak. The gudgeons are galvanized iron, like those shown in Fig. 24, secured to rudder by brass or copper rivets. The rudder, if intended for use in sailing, should be 14 inches wide; for rowing only, 11 inches. The thickness in either case is .75 inch.

The aperture for the tiller is .75 inch wide and 2 inches long. The sides of the rudder head are about 5 inches long, 3 wide, and .75 thick. Tiller about 20 inches long.

The sail, if one is used, should be about 9 feet 4 inches on mast; the peak, 5 feet 10 inches higher on a vertical line; 14 feet 8 inches long on boom, with a rise of 3 feet from the horizontal in that length.

Length of mast, 12 feet; diameter: butt, 3 inches; head, 1½ inch. Length of boom, omitting jaws, 13 feet 4 inches; ends, 1½ inch diameter; middle, 1¾ inch diameter. Length of sprit, 12 feet, and 1¼ inch diameter in middle. The sail is substantially as shown by Fig. 26.

Further information for sail will be given in description of Whitehall boat.

The mast-hole is seen in the bow-seat, Fig. 58. It should be 24 inches from extreme bow. The "step," *i.e.* the block which holds the lower end of the mast, will be described for Whitehall boat.

In our next article we propose to describe the construction of the Whitehall boat.

A SIXTEEN-DOLLAR FAMILY BOAT.

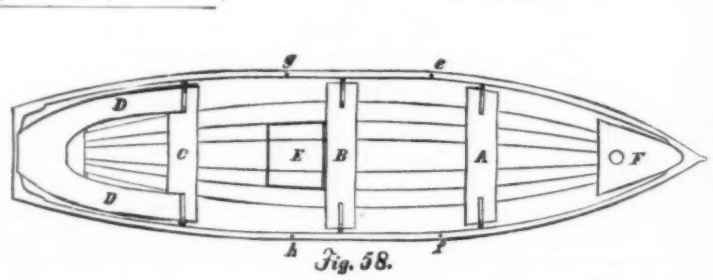


Fig. 58.

Table 2.

Rib ⊕	17.80 in.
" A	17.88 "
" B	18.08 "
" C	18.32 "
" D	18.72 "
" E	19.24 "
" F	19.84 "
" G	20.48 "
" H	21.32 "
Stem	22.20 "
Rib 1	17.88 "
" 2	18.04 "
" 3	18.32 "
" 4	18.68 "
" 5	19.20 "
" 6	19.72 "
Stern	20.24 "

Table 3.

Rib ⊕	24.00 in.
" A	24.00 "
" B	23.92 "
" C	23.48 "
" D	21.88 "
" E	19.52 "
" F	16.32 "
" G	12.00 "
" H	6.40 "
Stem	..... "
Rib 1	23.72 "
" 2	23.28 "
" 3	22.40 "
" 4	21.20 "
" 5	19.20 "
" 6	16.72 "
Stern	14.00 "

The groove or rabbit curves upward towards the stern, its upper edge being .48 in. above the upper edge of keel at frame 4;

1.68 in. at frame 5,
4.00 in. at frame 6,
8.00 in. at inside face of stern.

And, of course, the lower ends of ribs 4, 5, and 6 are placed immediately above the rabbit.

Dimensions (*Fig.* 36).

f	23.73 in.
g	to line III.
l	13.6 in.
k	22.8 "
Thickness of keel	1.00 "
Length of keel on lower edge	15 ft. 9.00 "
m	41.00 in.
n	2.00 "
p	1.25 "
q	21.49 "
r	13.49 "
a	.16 "
c, diagram 8	.16 "

Thickness of stern K, L, and H, 1 inch.

Diagram 7.

F	1.6 in.
G	1.6 "
w	4.9 "
u	.5 "
v	.5 "

Width of G at junction with F, .75 inch.

Assuming diagram III. to represent cross-section on line II.,

u is	.5 in.
v is	.5 "
F is	1.84 "
w is	1. "
Thickness of H at junction of F	.6 "

Diagram 1.

u is	.5 in.
v is	.5 "
F is	2.2 "
w is	1. "
Thickness of H at junction of F	.5 "

Small notches are cut in the lower sides of the frames near the keel, such as *a b*, Fig. 56, to permit the water to flow to the trap E, Fig. 58, where it is bailed out.

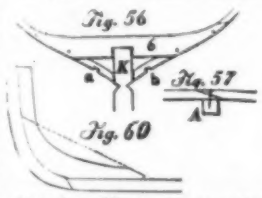
Bevel of Ribs (*Figs.* 40 *and* 41).

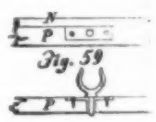
Rib ⊕	.00 in.	Rib 1	.00 in.
" A	.00 "	" 2	.04 "
" B	.00 "	" 3	.05 "
" C	.05 "	" 4	.08 "
" D	.07 "	" 5	.11 "
" E	.15 "	" 6	.12 "
" F	.19 "		
" G	.27 "		
" H	.32 "		

Frames F, G, H, and 4, 5, 6, are placed upon the bow and the stern deadwoods.

Fig. 56 shows the position of the bottom, which is indicated by 6, and the deadwood by K. The deadwood is not cut into. Ribs H, being so near the bow, need no bottom. Eight strakes may be used on each side, all .5 inch thick. The upper strake is white oak as before. The strakes that cross frame ⊕ at its greatest bends should be narrowest, so that they may lie close against the ribs.

The gunwale is 1 inch thick and 1.25 inch wide.





It is desirable to cut every plank to extend the full length of the boat, but if, for economy of materials or for some accidental cause, a break or "butt" is made, Fig. 57 will explain the method. A is a rib—for, of course, the butt can occur only at a timber.

Fig. 58 shows a deck plan, if we may so speak. The rowlocks are at *e*, *f*, *g*, and *h*. A, B, and C are thwarts constructed as before, and D D are the "stern sheets." The stern sheets are continued from the stern bench shown in Fig. 53, and nailed upon thwart C, abutting against the thwart knees.

The boards of the flooring—technically termed "ceiling"—are placed closely together, making a total width amidships of about a yard, and nailed to the bottoms. The trap E, about 14 inches long and 8 wide, is loose to permit bailing.

Dimensions.

Thwarts to be 7 inches below top of gunwale.

THE PORTUGUESE IRONCLAD, "VASCO DE GAMA."

AN ironclad vessel, which is to be the first ironclad possessed by the Portuguese Government, and to which the name of the "Vasco de Gama" has been given, recently had a successful trial trip. She has been built by the Thames Ironworks Shipbuilding Company, with engines by Messrs. Humphrys & Tennant. A model of her is to be seen in the Loan Collection of Scientific Apparatus at South Kensington, and another was shown by the King of Portugal to the Prince of Wales on his recent visit to Lisbon. The "Vasco de Gama" is a swift, handy, and powerful sea-going ironclad, mainly intended for the defence of the Tagus and of Lisbon Harbor. Her displacement tonnage is 2479 tons. Her length over all is 216 feet; her breadth, 40 feet; her depth is 25 feet. She is fitted with a ram, and has in her fixed octagonal battery, which projects beyond the sides between funnel and forecastle, two rifled Krupp 400-pounders, firing ahead, which can be so trailed that the shot will converge at a distance of 300 yards. The guns are of 26 centimetres. They are made of cast steel. There is also a stern-chaser, throwing shot of 110 lbs. It is of 15 centimetres bore, and, acting in conjunction with the turret guns at after ports, it can converge with either of them upon an object at 90 yards' distance. An all-round fire is thus attained. Four smaller guns are provided for signalling and other purposes. She also carries a Gatling gun, by Armstrong.

Great care has been taken in strengthening the bow, the armor-line being carried down to the extreme point of the ram, which is 8 feet below the water-line. The ram will thus be firmly supported, and the accident of shots piercing the hull when the bow lifts on the crest of a wave will not be likely to occur. There is a raised forecastle forward, which was designed for protection against the heavy seas sometimes to be encountered at the mouth of the Tagus. A poop aft covers the stern gun. The vessel is built upon the cellular principle, with double-bottom, iron water-tight decks and bulkheads, having in all 47 iron water-tight compartments. She is fitted with three masts, and the foremost is square-rigged, so that the "Vasco de Gama" will be capable of cruising to the Azores or to any part of the Portuguese colonies. Her draught is 19 feet aft and 16 feet 10 inches forward—that is, with 700 round of shot and 50 tons of coal in her, and with all her water and stores on board. The engines are vertical twin screw engines, constructed by Messrs. Humphrys & Tennant, according to the regulations applicable to engines for the vessels of our own Government. Their nominal horse-power is 450; they developed 3625 horse-power during the trial. The vessel, with her engines, cost about £125,000. The "Vasco de Gama" made four trial trips, the wind blowing up and down the course, a direction considered less favorable than when it blows athwart. The average speed attained was at the rate of 13¼ knots per hour. The ship turned in 430 feet, and occupied on the average about four minutes in the operation.—*London Times.*

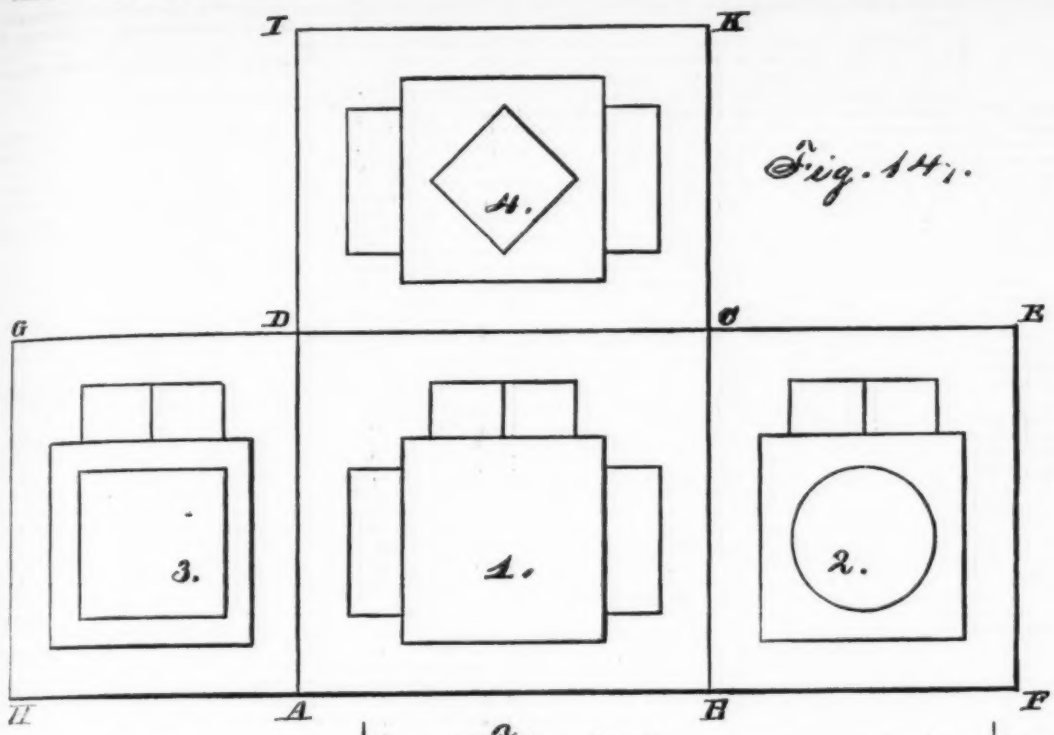


Fig. 147.

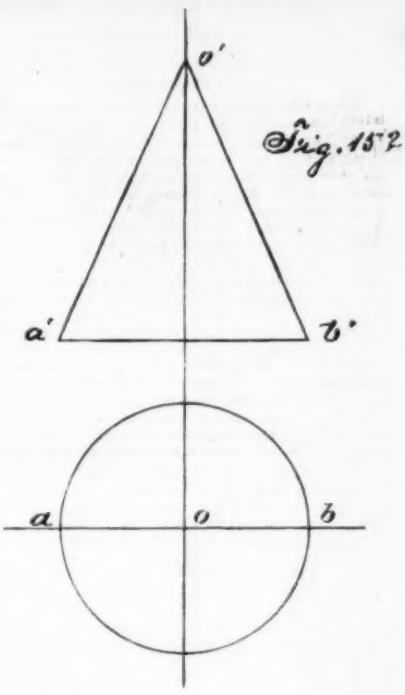
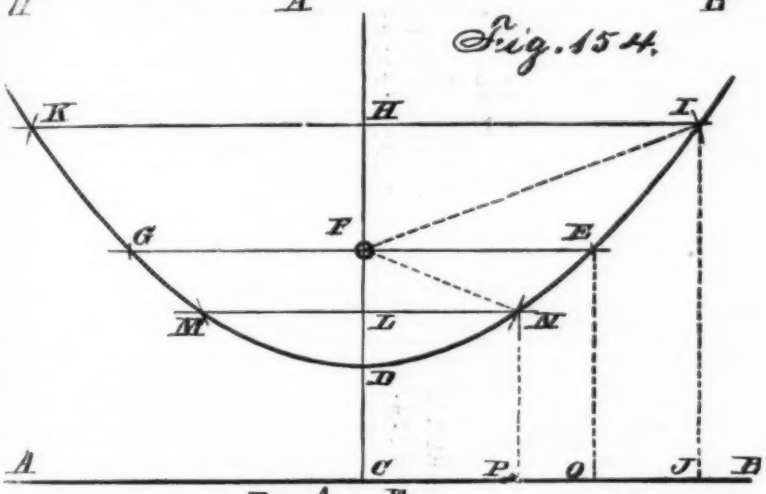


Fig. 152.

Fig. 154.



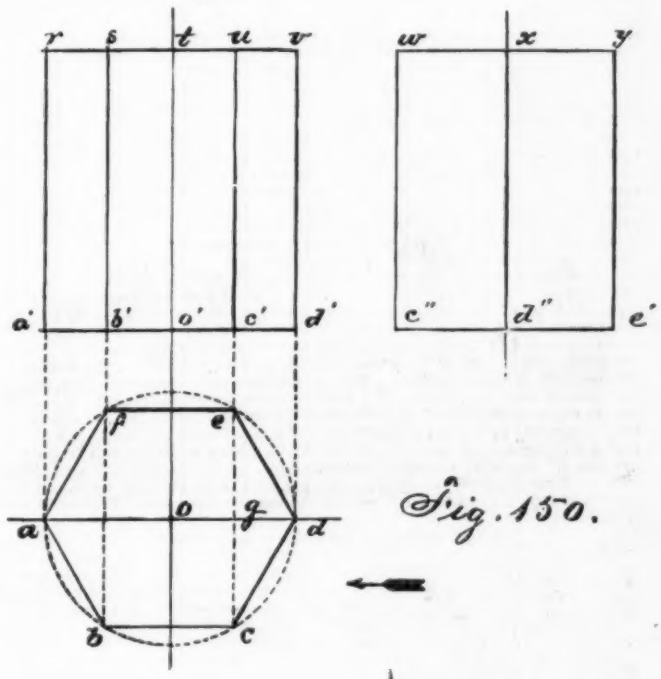


Fig. 150.

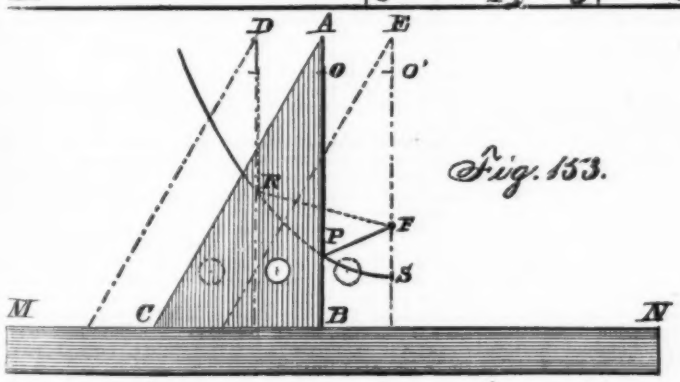


Fig. 153.

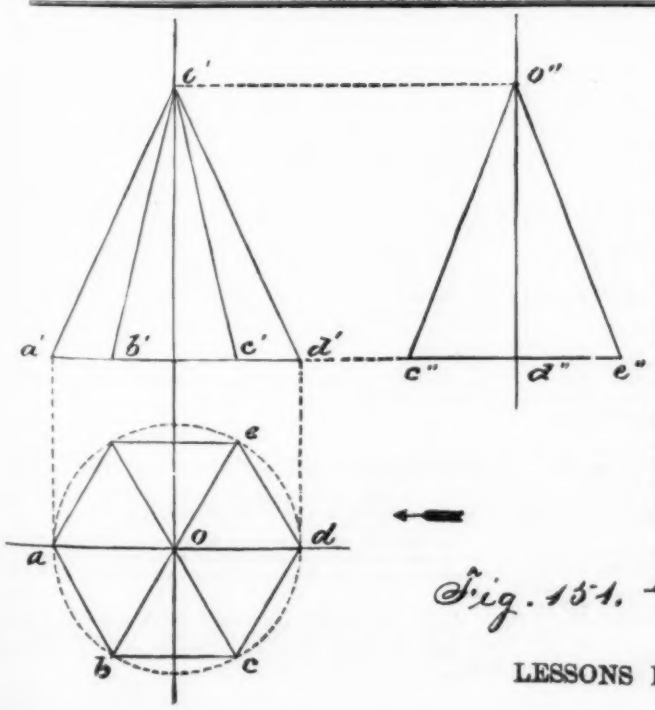


Fig. 151.

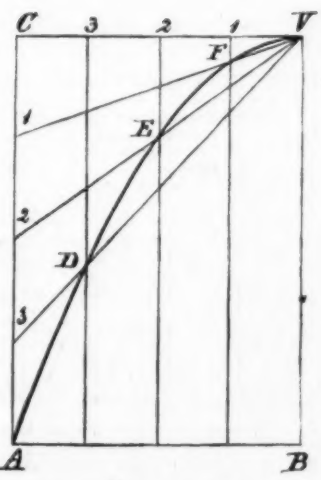


Fig. 155.

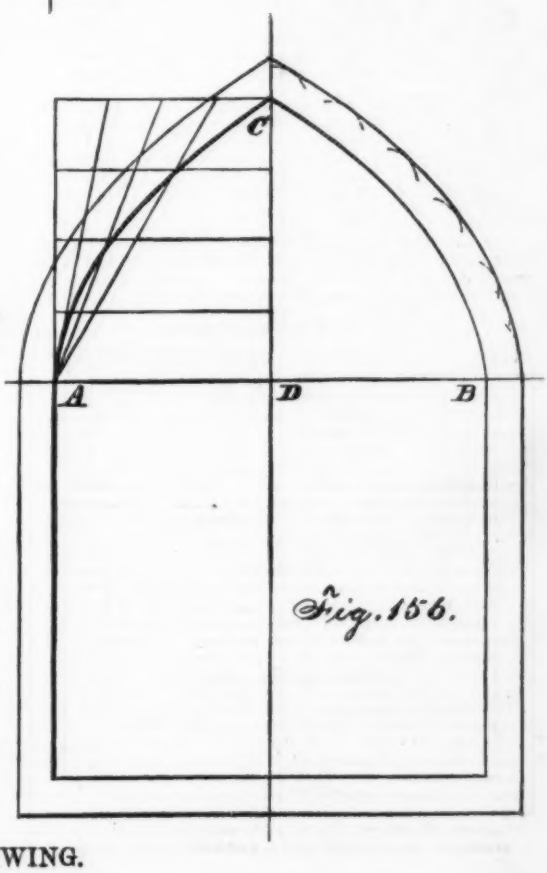


Fig. 156.

LESSONS IN MECHANICAL DRAWING.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MACCORD.

No. XVII.

(Continued from page 507.)

WE endeavored in the preceding lesson to illustrate the relation between an object and its "projection" (or one of the views which make up what is usually understood by a mechanical drawing), by supposing the body to be as one may say shot perpendicularly through the paper, thus making an opening which would correspond to its outline. The same crude illustration being applied separately to all the visible lines in the object, would result in a representation of each of them: or without supposing the body to move, the same result would be attained if we imagine perpendiculars to the paper to be drawn from every point in those lines. In either case it would make no difference whether we imagine the object to be in front of or behind the paper. But there is a reason for giving preference to the latter supposition, which is intimately connected with the most advantageous arrangement of the different views or projections upon the paper with relation to each other. This is a very important matter, as it materially affects the ease with which the drawings can be read and understood. We hope to make it clear, and possibly to make the mode of projection itself clearer than we may have already done, by the following illustration.

Let us imagine the object to be drawn, say a sewing-machine or a model of a locomotive, to be placed in a glass show-case, of which the front, sides, and top are rectangular plates. Standing in front of this, let the eye be directed perpendicularly against the plate; the point on the glass in front of the eye being also in front of some point of the object, will be seen in the same direction, and if marked on the glass will represent that point of the object—it is its projection. Now, the eye can not be perpendicularly in front of more than one point at a time, but we may suppose it to move around so as to come successively in front of all the points in all the lines. Each point of the object will thus be seen in order, and the point on the glass in front of each being marked, we shall have the projection of the whole body on the front plate of the show case. Next, let us go round to the right-hand side, then to the left-hand, then above, and look down upon the machine, and repeat the operation in each instance; in this way we shall obtain four different views.

Now, returning to the front, let us suppose the top and sides of our show case to be hinged to the front plate, so as to open outwardly, and let us unfold them until they coincide with the front-plate, forming one plane.

Our four projections will now be thus arranged: the front view occupying the central position, will have on the right the view of the object as seen from the right, on the left the view as seen from the left, and the top view above. This arrangement is not only the most simple and natural, but greatly facilitates the *reading* of the drawing, in this way: if the right and left sides are so different as to require separate views, as in the case of the locomotive model, above suggested, it is clear that the view taken from the right will contain lines indicating the form and thickness of parts near the right-hand end of the object, and their corresponding lines will therefore be near the right-hand side of the front and top views; and as a full idea of any part can be obtained only by comparing two at least of the projections, the propriety of the arrangement becomes evident. This may seem a prolix explanation of what is so obviously a matter of common-sense, but we regret to say that it is a flat contradiction of instructions frequently to be met with, which insist that the elevation of the right-hand side or end should be placed at the *left* side of the front elevation, and *vice versa*. And why? Because, forsooth, paper is opaque, and in order to see both paper and object, the first must be put behind the last; on which supposition, the projections would be made on the *inside* of our show-case instead of the outside, and we must imagine the sides and top to hinge on the back instead of the front, and then, you see, when you open it out, there you are, with the headlight of the locomotive next the tender, and the view of the fire-box cheek by jowl with the cow-catcher. Some are pleased to call this the French method, and if the Frenchmen do not resent it, we have no objection; but we decline to admit that it is any the better for being so. The making of the projections is one thing, but their arrangement is another; they are essentially independent of each other, notwithstanding their intimate relations, and when made we are at liberty to place them in any relative positions we please.

The result of the order of proceeding recommended is illustrated in Fig. 149, in which the show-case is represented as unfolded, A B C D being the front, D C K I the top, B C E F the right-hand side, and A D G H the left-hand. Upon these are drawn the projections 1, 2, 3, 4, in their order, of an object differing in its aspects on the four sides of which views are given; and it may be of service to those who find difficulty in imagining from these just how the object ought to look, to copy the figure on card-board, cut it out, and cutting half through the board on the lines A D, D C, B C, to fold it up, thus restoring the views drawn on the single plane to their actual positions in space, which may aid them in conceiving the form of the body.

It is now to be stated that the view 4 need not be placed above 1, as shown, but it may be placed below it with equal propriety; as if we were to cut off the part D C K I, and place it so that I K should coincide with A B. The reason of this is, that the eye is never supposed to be below the object, or at least it never should be: if the object be placed in a vertical position, it is easy, because it is customary, for the observer to look down upon it; or, if it seem more logical or satisfactory to say so, it is customary because it is easy; but it is neither to go below and look up. It is true that sometimes, though very rarely, it is necessary to show the appearance of what is to be the bottom of some part of a piece of mechanism when the whole is put together; and, of course, it is possible to draw such a view directly under the front elevation, and we have seen it done, attention being called to the fact that it is an unusual proceeding by marking it "bottom view," or even worse, "plan as seen from below." But we do not consider it advisable simply because it is possible and has been done; the mere fact that it is very unusual renders it liable to confuse the one who tries to read the drawing, and we think it impossible to insist too strongly upon the fact that a drawing can not be made too clear or too easy to read. This difficulty may always be avoided in making detail drawings (and it is only in detail drawings that such a view can by any possibility ever be of any use) in this way. A separate piece of any combination, evidently, may be placed in any convenient position for representation, since the detail plan is only to show how that piece is to be made, not how it is to be placed in the machine as a whole—that is the object of a "general drawing"; consequently we have only to lay it on its side, in order to have the top and bottom views correspond to the right and left end views, 2 and 3 in Fig. 149, or *vice versa*.

In a great many cases, perhaps in the majority, it matters little or nothing whether we make a view of the right-hand or the left-hand side, and one of them is sufficient: some forethought must be exercised, and consideration given to the question which view is preferable, in order to secure the best arrangement of all things on the paper; for we wish to impress it upon our readers, that it is not a matter of indifference whether the various views and groups of views which may be drawn upon a sheet be well or ill arranged. It is true that they may be all perfectly correct, and at the same time be badly arranged; we frequently see, for example, two views crowding each other, while the third is at a great distance from its neighbors, as though ashamed to be seen associating with them. But neatness, symmetry, and good taste in these minor things are not by any means to be neglected, and carelessness in regard to them is very likely, if not certain, to lead to carelessness in regard to other things.

We introduce in Fig. 150 the hexagonal prism, for the purpose of illustrating the steps in the construction of the drawing, it being a simple and familiar object, and one of which the draughtsman has always the model at hand, as he has only to look at his pencil from different directions, in order to see what is represented in these three views.

The first thing is to construct the top view, by describing a circle about the centre *a* with a radius equal to half the "long diameter," as it is sometimes called, of the hexagonal end, and having drawn the horizontal centre line *a d*, setting off *a b*, *a f*, *d c*, *d e* with the same radius, the sides of the hexagon being drawn with the 60° triangle, or the outline may be drawn with the triangle alone, as long ago explained; but when the greatest accuracy is required the compass should be used.

The front elevation is next to be drawn; having determined the height $a' r$, two lines are lightly pencilled for the upper and lower ends. Now it is to be noted that in the top view *b c* represents the face nearest us, and we know that *b* and *c* are the points which represent in that view two vertical lines whose length is equal to that of the prism—that is, to $a' r$, and this is true also of *a* and *d*. These lines will be seen in their true length in the front view, and perpendicularly over *a*, *b*, *c*, and *d*, because the relative distances from right to left are the same, whether we look at the object from above or from the front. With the triangle then we draw $a' r$, $b' s$, $c' u$, $d' v$ by simply placing the instrument against the upper edge of the T-square (held horizontally against the left end of the drawing-board), and sliding it along till its edge passes successively through *a*, *b*, *c*, and *d*, as indicated by the dotted lines $a\,a'$, $b\,b'$, etc. These dotted lines are introduced here simply to guide the eye in tracing the steps of the construction, and they, as well as the circle around the hexagon, are to be erased; the centre lines may be inked in or not, at the option of the student.

We have now to construct a third view, which we will suppose to be taken from the right-hand side; this is indicated by the arrow drawn on that side of the plan view, and it is apparent on inspection that *c* will be on the extreme left, *e* on the extreme right, and *d* in the centre. But neither *d* and *c*, nor *d* and *e*, will appear to be as far apart as they are in reality; the case is the same as in the front view, in which $c'\,d'$ is shorter than *c d*, and $a'\,b'$ than *a b*, the reason being that these lines are not viewed perpendicularly, but obliquely, the result of which, as explained and illustrated in the preceding lesson, is what is technically called a "foreshortening" of the line. It may be superfluous, but also it may not, to repeat that if a line be seen "side on," or perpendicularly, it will appear of its true length if seen "end on," that is in the direction of its length, it will appear as a point, and if seen obliquely, it will appear shorter than it really is by an amount depending on the degree of obliquity.

Bearing in mind, then, that the apparent distances from right to left are to be measured perpendicularly across, we proceed thus: the vertical guiding line $c\,c'$ cuts the horizontal centre line in *g*, and in looking at the plan view from the right, it is clear that *g* is directly behind *d*, and would therefore if visible be seen in the same direction—that is to say, in the required projection it would be represented by the same point d'', so that $g\,e$ and $g\,c$ are the measures of the apparent distances of *e* and *c* to the right and left of *d*. Therefore, we set off $d''\,e'$ equal to $g\,e$, $d''\,c''$ equal to $g\,c$, and then, recollecting that the heights are the same, whether we view the object from the south or from the east, that is to say from the front or from the right-hand side, we draw $e'\,w$, $d''\,x$, $e''\,y$, of a length equal to $a'\,r$, and $w\,y$ completes the view required.

Now, the principles involved here are all that are concerned in making any projection of any object in any position; and it may be worth while to summarize and recapitulate them, as an aid to the memory, for it is possible that some difficulty may be found in the construction of oblique views, and it certainly will be so if these principles are lost sight of. They may be thus stated, that each point in the front view is perpendicularly over (or under) its position in the plan view, so that distances measured "square across" from right to left are the same in these two views; that the heights of all points are the same in the front view and the side view, and that distances from right to left in the latter correspond to vertical measurements in the plan view. If these things are clearly understood and carefully observed, the student should be able to follow the explanations of succeeding exercises without serious difficulty; but unless they are, it will not be easy.

In Fig. 151 we give a drawing of a hexagonal pyramid, the base is laid out in the top view, as in Fig. 150; but as the edges of this solid are not vertical, but converge to a point directly over the centre of the base, they are represented in this view by radial lines *o a*, *o b*, etc. In constructing the front elevation, the points corresponding to *a*, *b*, *c*, etc., are found as before by projecting them perpendicularly to a', b', c', etc. The apex of the pyramid must be somewhere in the line drawn perpendicularly through *o*, and knowing the altitude we mark it accordingly at o', and then draw the edges, $o'\,a'$, $o'\,b'$, and so on, as seen in the front view—and it is clear that $a'\,o'$, $d'\,o'$, being parallel to the paper and seen perpendicularly, will appear of their true length, while $b'\,o'$, $c'\,o'$, are foreshortened. In the side view, d'' as before will appear in the centre, and as *o* is directly behind *d* in the plan when viewed from the right, o'' is vertically over d'', and at the same height above the base as o', which is indicated by the horizontal guiding line; the positions of e'' and c'' are found as before, and thus all the points required are located.

By comparing Fig. 150 with Fig. 145, it will be seen that the extreme outline of the cylinder is identical with that of the hexagonal prism in the front elevation. A moment's reflection will show that this must be so, since the edges of the prism lie in a cylinder whose base is the dotted circle in Fig. 150—as if we were to slip the prism into a tin tube of the right size. In like manner we may suppose our pyramid to be placed in a funnel, of such form that its edges should all touch it. This form would evidently be that of a cone, whose base should be a circle of a diameter equal to *a d*, Fig. 151, and the altitude equal to that of the pyramid; the drawing of this cone is given in Fig. 152, and needs no further explanation than to say that in working drawings it is a good plan to draw in the centre lines of such symmetrical bodies, as is done here and in the case of the cylinder, Fig. 145; they connect the views in a natural and unmistakable manner, and though in so simple a thing as either of these they may not serve any other purpose except that of definitely locating the centre in the plan or end view, they give it a workmanlike appearance, which, in itself, is a thing not to be despised.

As another exercise in the construction of curves, we give one or two methods of drawing the parabola. An idea of the nature of the curve may be obtained from Fig. 153, in which M N represents a ruler fixed in position, and A B C, a triangle which slides along its edge; F is a pin fixed in the board, to which is fastened one end of a string, which passes round the pencil P, and, running along the vertical side of the triangle, is fastened at its other end at any point O, near the vertex. Now, keeping the pencil close against the side of the triangle, slide the latter along until A reaches D; the pencil will move to R, R F being longer than P F, and as the string remains of the same length, whatever is added to P P must be subtracted from A P and therefore added to P B—that is to say, the distances of the pencil from the point F and from the line M N always increase or decrease equally as the triangle is moved; consequently there must be some line parallel to M N whose distance from the pencil shall always be equal to the distance of the pencil from the point F. We can very easily find the distance of this line from F by sliding the triangle along till its vertical side passes through F, when the pencil will be at S, and the string will be doubled from F to S; the required line will, then, evidently be as far below S as F is above it. Or if we know the distances E F and A O, as O will then be at O', and call the length of the string L, we shall have L − O' F = 2 F S, which will be the distance of the required line from F. We have then by this operation traced a curve which follows the law, that every point in it is equally distant from a given point and a given straight line. The curve is the parabola, the point is called the focus, and the line the directrix. We may now proceed on this definition to construct the curve by points, as shown in Fig. 154. Let A B be the directrix and F the focus; drop a perpendicular from F to A B, cutting that line in C, and bisect F C at D; this point satisfies the conditions, and therefore lies on the curve. Moreover, since we can not go nearer to A B without going farther from F, this is the point which is nearest to both the focus and the directrix, and it is called the vertex. If we draw through F a parallel to A B, and set off F E, F G, equal to F C, the points G and E also lie on the curve. So, also, if we draw any other parallel to A B, cutting C F, produced in H, for example, and about F as a centre, with H C as radius, describe arcs, cutting the parallel in I and K, these two points will satisfy the conditions, as, if we drop the perpendicular I J upon A B, we have I J = C H = F I.

Dropping the perpendicular E O on A B, we have by the construction F E O a right angle. If we draw a parallel to A B, cutting F C between F and D, thus finding the points M and N, and drop the perpendicular N P, we find F N P to be an obtuse angle, while F I J is acute, which will be the case with all the points which are more distant than the focus from the directrix. And as we shall always be able to make the intersections, no matter how far from the vertex we go (since H C, for example, is greater than H F), we see that the curve extends to infinity in the direction D H. Since, moreover, on each of the parallels K I, G E, M N, etc., we find two points, equidistant from F, and therefore from the line H C, we see that the curve is symmetrical with respect to this line, which is therefore called the axis. And finally, we observe that all curves of this kind are alike—that is, alike as all circles are alike, resembling each other in form and proportion, differing only in size: so that if any number of them were reduced by photography in such wise that the distance from the focus to the directrix should be the same in all, the curves would be identical.

Another method of drawing the parabola is shown in Fig. 155, in which V is the vertex, V B the axis, and A a point through which the curve is required to pass. Draw the rectangle A B V C, and divide V C and A C into the same number of equal (or proportional) parts, numbering the points of division from V toward C and from C toward A as shown. From V draw lines to the points on A C, and through the points on V C draw parallels to the axis; the intersections of the lines whose extremities have the same numbers will lie on the curve, as D, E, F, in the figure.

A neat application of this method is found in the drawing of a Gothic arch, shown in Fig. 156.

Let A B be the span and C D the rise of the arch, which is to be formed of two parabolic arcs. The construction is shown on the left, A being the vertex, A D the axis, and C a point in the curve, which is drawn as in the preceding figure; after which the other may be copied and reversed by the method of transferring explained in Lesson XIV. In the figure, we have shown the arch terminating an opening surrounded by a moulding of uniform breadth, and the mode of finding the outer curve is indicated on the right. It consists simply in striking a number of arcs of circles with a radius equal to the breadth of the moulding, and with their centres on the parabola, and drawing the required curve tangent to them. No point in the outer line is thus actually found, but the direction is marked with great accuracy: in fact, it may be said that as a general rule greater precision is attainable in this way than in drawing a line through points. In adding the shadow lines, the initial and terminal points must be, in fact, guessed at, as no method of drawing a tangent or determining a point of tangency, in relation to this curve, has been explained. But, as has been before remarked, this ought by this time to be unnecessary for this purpose. A tangent may be drawn in very lightly with the 45° triangle, and the eye can judge of the point of tangency with all the accuracy required, since the shadow line must taper out gradually so that its exact termination shall not be perceptible.

EXHIBITION NOTES.—ADMISSION CHARGES, ETC.

THE average attendance of paying visitors during the month of August was about 25,000 persons per diem.

The prices of admission have been ordered changed as follows: On the last two Saturdays of each month the price of admission shall be 25 cents, instead of 50 cents as heretofore.

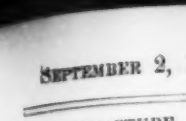
About one quarter of the space in Machinery Hall is occupied by exhibits from foreign countries, the remainder by exhibits of inventors and manufacturers in the United States.

MANUFACTURE AND WORKING OF STEEL.

By D. CHERNOFF, Assistant Manager of the Abouchoff Cast Steel Works, near St. Petersburgh. Translated by W. ANDERSON, M. Inst. C.E.

STEEL, as generally used in the arts, is a combination of iron and carbon. The purer these elements in steel the higher are its qualities. The best steel that has ever been made in any age or country is, without question, "boulat" (the sabre steel of the Tartars). The special qualities of boulat, and especially the markings appearing on its surface, have sent many investigators on a wrong scent; all thought to find the extraordinary quality of this steel in some special mixtures. Careful analyses have been made, but, to the surprise of all, nothing has been found competent to explain the presence of the characteristic veining. Inasmuch as the veining of boulat is closely connected with its quality, it was attempted to find substances which, being melted with the steel, would produce the markings required. Steel was melted with various metals, with platinum, silver, and so on, and veinings were, no doubt, produced; but in the first place, they were far from having the same regularity and beauty, and secondly, as well as chiefly, the steel produced was always inferior to boulat. The peculiarity of the veining of boulat lies also in this, that if you heat a good specimen of the steel with clearly marked veining to a bright red heat, and then allow it to cool, it will be impossible to restore the markings, no matter how long you treat the surfaces with acid. The veining, on the other hand, produced by the mixture of metals never disappears, however much the steel may be heated. But if the piece of boulat in which the veining has disappeared be melted again, then, if certain conditions in the cooling of the ingot are observed, the veining appears again, though of a somewhat different design; and in this manner it is possible to produce or annihilate the pattern several times. The investigations of Anosoff have clearly shown that the problem is solved in the purity of the steel, and he has succeeded, as is well known, in producing the very highest qualities of Eastern boulat. On a former occasion I spoke of the observations I had made on the ribbons of dead tint observable on the surfaces of steel guns in the lathe. By means of careful daily records of the forging of the gun ingots, I found that these tints appeared in the boundaries between the hot and the cold portions of the ingot being forged—that is to say, always at those points up to which the ingot was pushed into the furnace. The position and appearance of the strips of dead tint always coincided with the position and form of the limit of heating. If a spot so noted by me was afterwards reheated, then the ribbon of dead tint no longer appeared after turning in the lathe. Besides this, some of these ribbons would disappear as a greater or less thickness of metal was turned off; others penetrated right through the mass of the gun, and never disappeared.

It is further remarkable that although, at times, the transition from the heated to the cold portion of the ingot was so gradual that it was impossible to assign any limit, yet the ribbon of dead tint developed by the turning of the surface of the gun, and corresponding to the above ill-defined limit of heating, was so clearly marked, that it was easy to trace its boundaries with a pencil on the surface of the gun. It must be remarked also that the ribbon has only one well-defined margin—that which was turned towards the cold end of the ingot; the other margin is shaded off imperceptibly into the normal tint of the steel. Wishing to investigate the effects of the steam hammer on the structure of steel, I heated a 4½-in. ingot to a bright red color, and subjected it to two heavy blows of a 5-ton hammer, so that one third the length was not touched at all; the second third was flattened to 3 in., and the last received two cross blows, under each of which there was a compression of at least 1½ in. The ingot was then left to cool in the open air, and on being broken it was found that the appearance of the structure of each of the three sections remained identical, not only to the naked eye, but to the most careful microscopical examinations.



I have also drawn attention to the circumstance that, on one occasion, when experimenting on the influence of the temperature to which steel was heated on its hardness in tempering, I ordered a smith to heat a piece of steel to dull red, but he, by mistake, heated it bright red. Wishing to rectify the error, I did not at once plunge the steel into water, but let it first cool down to dull red, and then immersed it. Although the steel was of a quality capable of extreme hardness in tempering, the immersion not only did not make it hard, but actually made it sensibly softer. I have recalled the above circumstances, because in connection with many others they induced me to investigate the influence of temperature on steel, and formed points of departure from my researches. Space will not allow of my describing my experiments in detail. I must content myself with stating the conclusions to which I have arrived.

STEEL CRYSTALS BY MELTING.

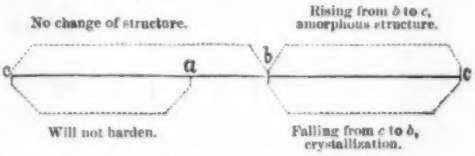
If steel melted in a crucible is constantly kept in violent agitation while cooling, agitation violent enough to keep all its particles in motion, then the cold ingot produced will have a very finely crystallized structure; if, on the other hand, the melted steel is allowed to cool in perfect quiet, then the resulting casting will consist of large, well-developed crystals. The appearance of these crystals, and generally the tendency to crystallize under these circumstances, will depend on the purity of the steel. As I have already stated, the ultimate purity of the steel consists in that of its two component elements, iron and carbon, and that the best steel is composed of only these two elements. With reference to other elements, the presence of which is supposed to influence the quality of steel, it is impossible to avoid mentioning the opinion of Fremy, who considers nitrogen so essential, not only to the formation, but to the very existence of steel, that he has laid down the proposition that "if the nitrogen is taken away from steel it will cease to be steel."—*Comptes Rendus*, vol. lii., April, 1861; and the supporters of this theory, who go further, and affirm that steel is a union of iron with cyanogen, which can even be seen burning with a violent flame during the process of casting steel. However, up to the present time—1868—the most careful researches of Caron, Marchand, Biot, Boussingault, Rammelsberg, and others, have not confirmed the assertions of Fremy; for, on the one hand, nitrogen is found also in soft wrought iron and in cast iron, and on the other, the quantity of nitrogen found in steel is very variable, and bearing no fixed relation to the quantity of carbon; and furthermore, it exists in such small quantities as to be less than a tenth part of the carbon. For instance, Bussengol found 0·00057 part of nitrogen in cast-steel, and 0.00124 part in soft wrought iron.—*Comptes Rendus*, vol. lii., p. 1251. On another occasion, he found in Krupp steel 0.00022 part of nitrogen, and in soft wrought iron and in cast steel, 0.00007 each.—*Comptes Rendus*, vol. liii., p. 9.

INFLUENCE OF DIFFERENT METALS ON THE QUALITY OF STEEL.

With reference to the influence of different metals on the quality of steel, it is necessary to state that some of them communicate a particular color, some diminish the tendency to rust, and others displacing the carbon, enable the steel to acquire very great hardness in tempering, and so on; but the greater number of substances combined with steel, even in its most insignificant proportions, very considerably lower its quality. For example, the malleability of steel, being in direct relation to the quantity of carbon contained in it, is materially lowered by the presence of foreign substances. Bessemer steel No. 1, containing 2 per cent of carbon, is hardly malleable—Boman, *Das Bessemern in Schweden*, 1864, whereas, according to Anosoff, pure steel retains its malleability with 3 per cent of carbon, forming the hardest boulat. Speaking generally, all the efforts of metallurgists to obtain the highest qualities of steel should be directed to separating impurities from the raw materials, so that the produce of their operations should be a combination of iron and carbon; and all the specifics and nostrums forming the subjects of so-called secrets will be found to consist, in effect, not in the introduction of new materials, but in purifying the raw, and only, as a last expedient, driving out pernicious impurities by means of substances less harmful. It may as well be said that tungsten steel has not proved a dangerous rival to carbon steel. The fact is that tungsten, when steel containing it is heated, gradually oxidizes, at first on the surface of the ingots, and then by degrees to the very centre, so that after a few heats the steel loses its peculiar qualities. This oxidation takes place even at ordinary temperatures. As I have already stated, steel, cast and allowed to cool quietly, assumes a crystalline structure. If you heat such an ingot to a bright red heat, and allow it to cool without working it in any way, then on breaking the mass you will find that its structure has been altered. In order to explain the law regulating the change of structure produced by heating, I draw a line, on which, as on the scale of a thermometer, I shall mark certain points, corresponding to several determined temperatures.

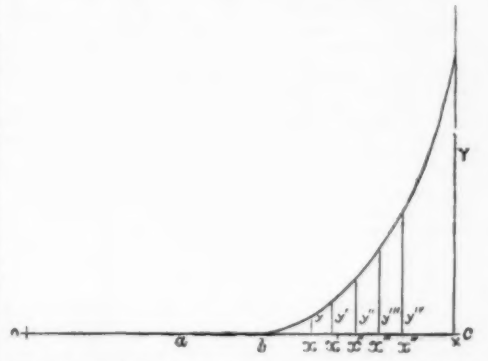
Let the point *o* be the zero of the thermometric scale: *a* marks the temperature of dark cherry-red; *b* red, but not sparkling; and *c* the melting point of a given sample of steel. The points *a*, *b*, and *c* have no permanent place on the scale, but vary with the quality of the steel (in pure steel this variation depends directly on the quantity of carbon contained); the harder the steel the nearer these points move to *o*, and the softer the steel the farther off, and, speaking generally, with varying rates. The limits of these movements are sufficiently narrow, so that an inexperienced eye would hardly discern them. Not having suitable apparatus for measuring the temperatures, I have been compelled to denote them by the colors exhibited in heating, the various shades of which only an experienced eye can appreciate; and it must be added that the colors named have reference only to hard and medium qualities of steel; for in the very soft kinds, nearly approaching to wrought-iron, the points *a* and *b* recede very far, so that, for example, in wrought-iron the point *b* corresponds to white heat.

The definition of the point *a* is as follows: Steel, however hard it may be, will not harden if heated to a temperature lower than *a*, however quickly it is cooled; on the contrary, it will get sensibly softer and more easily worked with the file. Not having time to enter into the explanation of this phenomenon, I will refer to the investigation of Jullien (*Les affinités capillaires et les phénomènes de la trempe mis en présence*. Paris, 1866) on tempering in general, from which he deduces the very probable conclusion that steel, in cooling from a red heat, appropriates a certain amount of latent heat, the quantity of which is directly dependent on the rate of cooling; so that the quicker the steel is cooled the greater quantity of latent heat it will contain; but if the rate of cooling diminishes below a certain limit, then the latent heat all escapes, and no hardening can take place. The actual hardening Jullien explains by the supposition that the carbon assumes an abnormal crystalline condition. I will add from myself that all this takes place only when steel is heated above the point marked *a* on our scale. The definition of the point *b* is that steel heated to a lower temperature than *b* does not change its structure, whether cooled quickly or slowly. This expression, however, must be taken conditionally, because steel, during long periods of time, and especially under the influence of shocks or vibrations, and at ordinary temperatures, but to a less extent than wrought iron, changes from the finely granular to the coarse crystalline structure; and as regards the heated, and therefore softened condition, and especially at temperatures approximating to that indicated by the point *b*, it is probable that, with the greater facility of motion, the change of structure will take place more rapidly. In my own experiments I have kept pieces of steel at temperatures near to *b* for about eight hours, but after cooling slowly in hot sand I have been unable to detect any change of structure.



CHANGE FROM CRYSTALLINE TO WAX-LIKE STRUCTURE.

As soon as the temperature has reached the point *b* the substance of steel quickly passes from the granular (or, speaking generally, crystalline) condition to the amorphous (wax-like structure), which it retains up to its melting point, that is, to the point *c*. In this condition steel possesses the property of incompressibility, and at the same time (with respect to the permanence of the amorphism) has an analogy to an exceedingly concentrated solution of a strongly crystalline salt. To make my meaning clearer, imagine a piece of crystallized alum put into a beaker and carefully heated. On attaining a certain determined temperature the piece of alum will appear as if damp, the separate crystals forming the mass will seem, as it were, to be sticking or clinging to each other, forming a mass on the point of melting, and which actually gradually becomes fluid and forms a solution of the crystals of alum in their own water of crystallization. Now if this fluid mass is allowed to cool, it will again crystallize, and according to the conditions under which this cooling takes place we can obtain any quality of crystals, from the coarsest to grains so fine as to be scarcely perceptible to the naked eye. If the fluid is allowed to cool very slowly, and in perfect quiet, then large regular-shaped, well-developed crystals will be formed; but if, with the same gradual cooling, the liquid is kept in constant agitation (shaken up), the crystals will come out very small. Allowed to cool quietly but rapidly, the crystals will also be small; and, finally, the least favorable condition for crystallization is when the liquid cools rapidly, and is at the same time violently agitated. In a word, all depends upon the greater or less *time* and the greater or less freedom of motion the particles possess among themselves for collection into crystals; the first condition depends upon the rate of cooling, the second, upon quiet and the greater or less density (thickness) of the mass undergoing crystallization. The same changes take place in the structure of steel heated above the point *b*. The higher steel is heated the softer it becomes, the greater, therefore, is the liberty its particles possess to group themselves into crystals—if the quiet of the mass is not disturbed by extraneous forces; and the slower the temperature is suffered to fall to the point *b* the more time they have for the purpose. At temperatures lower than *b*, as already stated, the structure of the mass does not alter. In this case the action of carbon on iron may be likened to that of water of crystallization on its salt; that is, it may be supposed that carbon at the temperature *b* begins to dissolve iron just like the water of crystallization at certain temperatures commences to dissolve the solid substance of the salt. This hypothesis receives confirmation in the process of cementation, in which the iron must be heated to above a certain temperature or no effect will be produced, no matter how long the bars remain in contact with the carbon; it is very probable that the temperature at which carbon begins to be absorbed in cementation is very near to the point *b*.



The power of steel to become granular may be graphically illustrated thus: On our scale of temperatures *o*, *a*, *b*, *c*, a curved line rises from the point *b*, and the ordinates *y y*, etc., of this curve represent the degree of development of the grains for the corresponding temperatures *x x*, which become the abscissæ, but necessarily under similar conditions of cooling from the several temperatures *x x* to the temperature *b*. At some temperature X lower than the melting point C, the ordinate Y becomes infinite, and an asymptote to the curve, the practical significance of which is apparent in the well-known fact that steel will not endure high welding heat, but falls to pieces in the fire; and the harder the steel the lower is the temperature at which this takes place, and, therefore, the nearer is the temperature X to *o*, and the farther from C.

FINE AND COARSE GRAINED STEEL.

In manufacturing articles of steel we try to get them as much as possible of a fine-grained structure, especially strength or toughness is the first object sought. I say that it better to obtain steel of a finely crystalline structure, because numerous experiments have demonstrated that the greater the preponderance of the crystalline formation, the larger and more regular the crystals are in a given piece of steel, the less resistance does it offer to fracture, the less tenacity does it possess, and, therefore, men connected practically with the working of steel recognize its qualities by the appearance of its fracture. If the fracture is fine-grained, they say the steel is well forged and consolidated; if it is coarse-grained, it is badly forged and of an open character.

Although we are in the habit of associating with the forging of steel an idea of increased density, yet, in reality, it appears that, in most cases, forging only changes the form of the steel, and, according to the relations between the force of the blows and the thickness of the piece of steel being worked, hinders crystallization of the mass to a greater or less degree, but does not increase its density—I am speaking only of forging above the temperature *b*, such as is general in working large ingots. The force of the blows is too small to vanquish that gigantic molecular force of heat that keeps the particles of steel at a definite distance one from the other. The problem of forging—at temperatures higher than *b*—consists in this, that while changing the form of the mass of steel it should have no time to cool and crystallize quietly, but should be kept in the amorphous condition till such time as the temperature sinks below the point *b*, after which, if left to cool in quiet, the mass will no longer crystallize, but will possess great tenacity and homogeneity of structure, so that it will oppose in all its parts a uniform resistance to external forces, of course supposing the chemical composition of the mass throughout to be the same. But if the problem of forging was limited to the above conditions, it is easily seen that working steel under the hammer might be dispensed with, and the required form given at once by casting in suitable moulds, and preventing crystallization by rapid cooling. In reality, however, things are very different.

DIFFICULTIES OF FORGING STEEL.

The difficulty of forging is aggravated by the circumstance that the cast ingots out of which guns, for example, have to be made are full of pores filled with gas, bubbles penetrating the interior as well as the surface of the mass, and also with scales and cracks due to contraction, so that, as the castings are delivered from the foundry, it would be impossible to make use of them. These bubbles and cracks must be squeezed or pressed together, and this can only be done by powerful mechanical means—by heavy forging. Simply unforged cast steel is neither less dense nor less strong than steel of the same molecular structure, and forged at temperatures higher than *b*. To convince myself of this, I made a number of experiments, first on the density of the two kinds of steel, and found that in most cases forging had diminished the specific gravity; and, secondly, I found that the tenacity of the cast steel was in nowise less than that of the forged, provided, as I said before, both have the same structure. To prove this, I took a cast ingot of coarse crystalline structure. I had it cut longitudinally into four parts. One of these parts was turned down in the lathe, and tested in the proving machine. The second piece was heated to bright red, and vigorously forged under a 3-ton hammer, the forging

being stopped when the temperature fell to very nearly the point *b*; the specimen was then turned down, and also tested in the proving machine. The third piece was made red hot, very nearly the same temperature at which the forging of the second piece terminated, and was allowed to cool in the open air without being forged. Having broken a small piece off this last specimen, I found that it had assumed a finely granular structure very similar to that of the second forged specimen. The third sample was also turned down in the lathe, and tested. The three specimens are now before you, and you may judge for yourselves what varieties of structure the self-same piece of steel may be made to assume. The results of the experiments are given in the following table:

	Ultimate Strength, in tons per sq. in.	Ultimate extension.	Diameter of specimen—inch.	Dynamic resistance per cubic in. in in. tons Ultimate Strength × ⅛ elongation.
1st. Unforged specimen.	34.8	0.023	0.885	0.8
2d. Vigorously forged specimen.....	41.5	0.053	0.85	1.1
3d. Not forged, but made finely granular by heating.....	38.7	0.166	0.63	3.21

I must also remark that on the fractured surface of the third sample, as you may observe for yourselves, there is a spot of iron occupying about one sixth of the area, and which was undoubtedly the cause of premature fracture, for the appearance of the fracture clearly shows that it began at that spot. In order to establish the propositions I have advanced, it will, of course, be necessary to institute a complete series of experiments.* As regards trials by bending and breaking under the hammer, an immense number of experiments have convinced me of the correctness of my views.

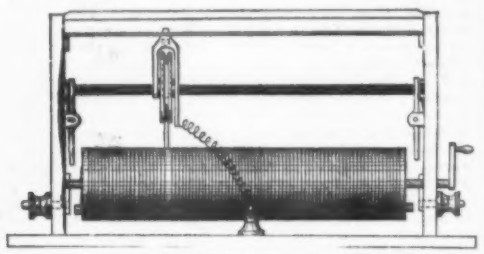
[To be continued.]

GROVES'S IMPROVED RHEOSTAT.

THIS instrument, which is shown by the Figure, consists primarily of a cylinder of hard wood or ebonite on which a screw thread is cut. In the groove formed by this screw thread a wire of brass or German-silver is wound, the ends of which are fixed at the terminations of the cylinder and are in connection with the axes of the latter. Springs which press against these axes continue the connection on to terminals fixed to the case of the instrument.

One of the turns of wire passes over a metal pulley, whose diameter is equal to that of the cylinder. This pulley runs on a metal axis, which is tapped with a screw thread from end to end. The pitch of the screw being made the same as that on the cylinder, by turning the handle attached to the latter, the position of the turn of wire can be shifted to any position on the cylinder, thereby altering the proportionate quantity of wire on either side of the pulley.

In order to keep the turn of wire at a continual tension, the axis on which the pulley turns is hinged at one end, the other end being kept constantly pressed upwards by means of a light spring.



GROVES'S IMPROVED RHEOSTAT.

To prevent overwinding, small levers are placed at each end of the instrument. The lower ends of these levers being moved forward when the pulley presses against their upper ends, come in the way of projecting pieces of metal fixed to the ends of the cylinder, and thereby prevent it further turning.

The frame of the pulley is connected by means of a long spiral of wire, with a third terminal fixed to the base of the instrument, good connection being kept up with the pulley by means of a spring fixed to the frame of the latter pressing against its periphery.

In order to be able to note the number of turns of wire on either side of the pulley, the top of the frame of the latter slides along a graduated scale which is marked with divisions corresponding to the turns of wire on the cylinder.

The whole instrument is enclosed in thick glass slides and top, so as to exclude the dust and damp.

The great advantage of the instrument over the original form of Wheatstone and the later one of Jacobi is that, as regards the former, both resistances on either side of the pulley are available at once, and as regards the latter, much better contact is made and maintained than when the simple edge of a wheel is used to press against the wire wound on the cylinder; for in Mr. Groves's instrument half the circumference of the pulley is embraced by the turn of wire.

To use the instrument for simply adding a resistance in a circuit, the middle and one of the end terminals would be used, and to use it for the proportional parts in a Wheatstone-bridge, all three terminals would be called into requisition, the battery being connected to the middle terminal, and the galvanometer and other resistances to the other two.

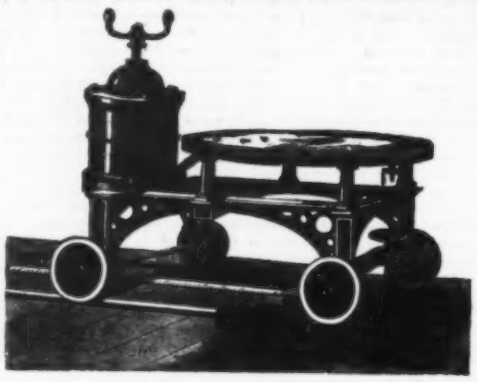
For use with the Wheatstone-bridge, the instrument possesses many advantages over ordinary resistance coils, as it can be adjusted to bring the needle of the galvanometer to zero very much more quickly and to a greater degree of nicety than with the ordinary resistance coils. This rapidity of adjustment is very necessary in testing for faults in submarine cables. For the duplex telegraph system it would also be of great service.

In the instruments usually made, there are 260 turns, each having a resistance of about 1 ohm, but they can of course be made to suit any requirement.—*Telegraphic Journal.*

* 1875. Since the above was written, numerous experiments at the Abouchoff Works have fully demonstrated the truth of my views.

A MERCURY ASTRONOMICAL MIRROR.

ASTRONOMERS often make use of mirrors to reflect the images of stars under observation into their instruments. The best reflecting surface that can be employed is that of mercury, which besides always remains horizontal. In order, however, to obtain perfect reflection it is necessary to remove the film which forms over the surface of the metal.



A MERCURY ASTRONOMICAL MIRROR.

The apparatus herewith illustrated, devised by M. Collin, renders this last-mentioned operation unnecessary, for whenever the mercury is used, it becomes cleaned during its escape from the reservoir in which it is kept hermetically enclosed. It is thus always pure and brilliant. The reservoir shown on the left is a pump cylinder, in which a piston is operated by means of the screw represented above. This forces the metal out upon a large circular shallow vessel through a connecting tube. In order to operate the apparatus conveniently, it is mounted on a carriage on rails. Between the latter is a graduated scale, so that the mirror can be readjusted at any desired point. The vertical screw shown on the right serves to fix it in place.

REDIER'S REGISTERING BAROMETER.

THE annexed illustrations represent a new registering barometer, made by M. Redier of Paris, which is constructed as follows: In one branch of the ordinary siphon barom-

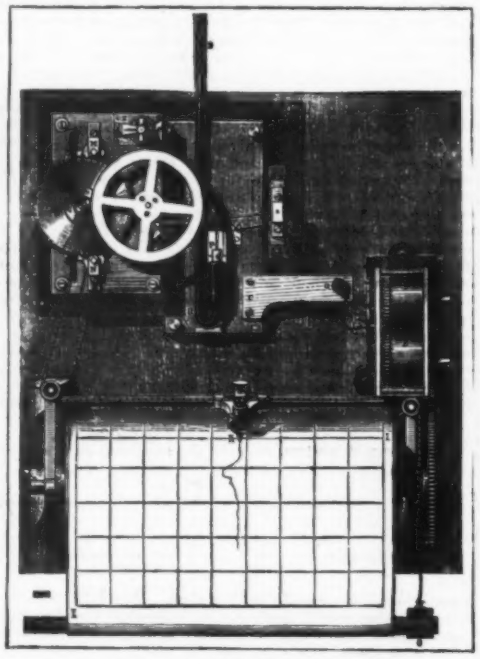


FIG. 1.—REDIER'S REGISTERING BAROMETER.

eter BB is an ivory float F, on which is fastened a very light steel pointer, on the apex of which is a horizontal needle A. One end of the latter is made in a small hook, or catch. Affixed to the supporting frame of the instrument is clock mechanism M N. The train M is terminated by a chronometer escapement, and the train N by a light fly-wheel V, which turns with great rapidity. The two trains are calculated so that the velocity of the fly-wheel may be double that of the escapement. A satellite gear unites these two movements, and on the axis of the satellite is carried the wheel Y, which engages with a pinion on which is mounted the large four-armed wheel shown. A chain from the latter moves the registering pencil K in one or the other direction, according as the wheel turns to the right or left. The axis of the large wheel has a pinion which engages in a rack not shown, whereby the plate which carries the barometer is moved; so that when the pencil is caused to travel the barometer is also moved in a vertical direction. The needle A touches one of the wings of the fly-wheel V with its hook end. The escapement E of the train M works constantly, and so tends to carry the large wheel from right to left, and to raise the barometer upward. As the barometer is thus moved, however, the needle A is disengaged from the fly-wheel V. The latter is then free to turn, and as its velocity equals 2, that of the escapement being 1, it draws the large wheel from left to right, and causes the barometer to descend. The needle then once more catches the fly-wheel V.

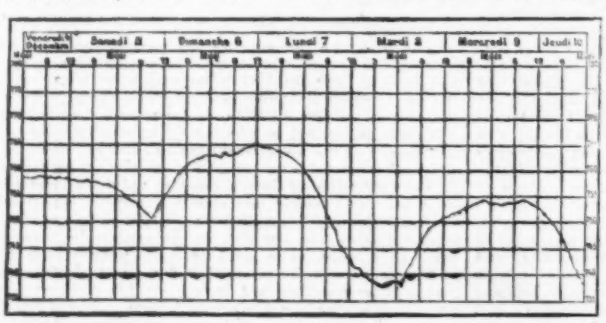


FIG. 2.

When atmospheric pressure does not change, the pencil describes a right line—should it augment however, the mercury sinks in the barometer—the needle is carried down and the hook engages still further on the fly-wheel. It will then take longer for the escapement E to cause the disengagement of the fly-wheel. Consequently the large pulley turns in the same direction for a period proportional to the change of pressure, and the mark left on the paper indicates this movement. If on the other hand the pressure diminishes, the fly-wheel is freed and the separation between wheel and needle will be greater in degree proportional to the diminution of pressure. A movement of the pencil to the right therefore indicates a rise in the mercury—to the left, a fall.

The paper on which the indications are received is divided into spaces horizontally to represent hours, and vertically to represent varying degrees of pressure. It is wrapped around a cylinder which is rotated by clock-work R, over given distances, to correspond with the ruling of the paper. The length of the latter may comprise indications for several days, as shown in Fig. 2, on which the marking for a week is exhibited. The little hammer O is caused to strike gentle blows on the barometer support, so as to keep the mercury column always free and lightly shaken.

THE "FRUE VANNER."

A SHORT time since we reported the trial of the Frue Vanner at New Consols, near Gunnislake, when it was seen in operation by many mining gentlemen, and very favorable opinions expressed of this highly ingenious American invention. The arrangements for driving it at New Consols were, however, of a temporary character; and the mine itself, though the operations there carried on have attracted large numbers of visitors, was too remote from the chief mining districts of West Cornwall to allow of the Vanner becoming so widely known among practical miners as was desirable. Mr. Walter McDermott, the agent, therefore, arranged for a trial of the Vanner at West Wheal Seton. A large machine has accordingly been fixed there in such a way that it can be properly worked, and its capabilities fully tested; and during the past week it has been inspected in operation by many mine managers, dressers, and engineers—on Monday last by the whole body of the County Rockborer Committee. The Vanner will remain at work at West Wheal Seton for another week.

The principle of the Frue Vanner was explained at the time of the experiments at New Consols, but it will be advisable to remind our readers that it consists of a wide travelling belt of canvas and india-rubber, with a smooth rubber surface and deep flanges on each side, which travels slowly upward, and on the upper end of which the stuff to be dressed is carried by a launder and head. This belt, in addition to its upward motion, has a rapid shaking action imparted by cranks driven from a side shaft, and the result is that while the waste is washed off the belt, at the bottom the mineral settles upon and adheres to it, and is carried over the upper cylinder and down into a coffer through the water in which the belt passes, and into which all the mineral is washed. The object throughout is, of course, to imitate the vanning action of the miner's shovel, the most efficient separater and dresser known. The machine at West Seton is larger than that put up at New Consols, the belt being 4 feet in breadth, and its upper surface 12 feet in length. The inclination of the belt is 6 inches in 1 foot, and the travelling speed about 10 feet a minute, while the shakes are going at the rate of about 180 in the same space of time. But the speed, of course, depends upon the character and quality of the stuff. At West Seton just now the Vanner has been tried on the tails of the slimes, and has thoroughly proved its efficiency by taking out all the mineral that is worth any thing, that which passes off being worthless, and utterly incapable of being treated profitably.

It must not be understood, however, that the special purpose of the Vanner is to deal with these tailings. The way to turn the machine to profitable account is to set it at work on the slimes from the stamps direct, putting a second Vanner to take the tailings of the first. In this way practically all the tin, or whatever is the ore under treatment, can be saved, and no small fortunes washed into Red Rivers. Then, to secure due economy of power and superintendence, several machines must be driven together, it taking about two horse-power to work one, while one hand can attend to many. The characteristic of Frue's Vanner is, in short, efficiency and economy secured by complete dressing; and not by cheapness of operation merely, in which respect, in a county of cheap labor like Cornwall, the common frames can hardly be beaten.

There is, we believe, but one opinion among the gentlemen who have seen the Vanner in work as to the excellent manner in which the principle is carried out, and the satisfactory results obtained. The two desiderata in working are exactness of feed and regularity of speed, and these provided, the machine automatically produces the most uniform results. Practically the only wear is in the belt, and that is not great, while the surface can at any time be easily and cheaply renewed by an application of liquid rubber.—*Mining Journal.*

THE HOMERIC METAL, KYANOS.

IT is stated in the *Iliad* that a metallic substance of a blue color was employed in the decoration of the shield and arms of Hector, and of the palace of Æneas. Perforated lumps of such a material were discovered by Schliemann during his excavations at Hissarlik (Troy?). An analytical examination by Landerer (*Berg. Hüttenm. Zeitung*) has shown them to be sulphide of copper. The art of coloring the metal was known to the coppersmiths of Corinth, who plunged the heated copper into the fountain of Peirene. It appears not impossible that this was a sulphur spring, and that the blue color may have been given to the metal by plunging it in a heated state into the water, and converting the surface into copper sulphide.